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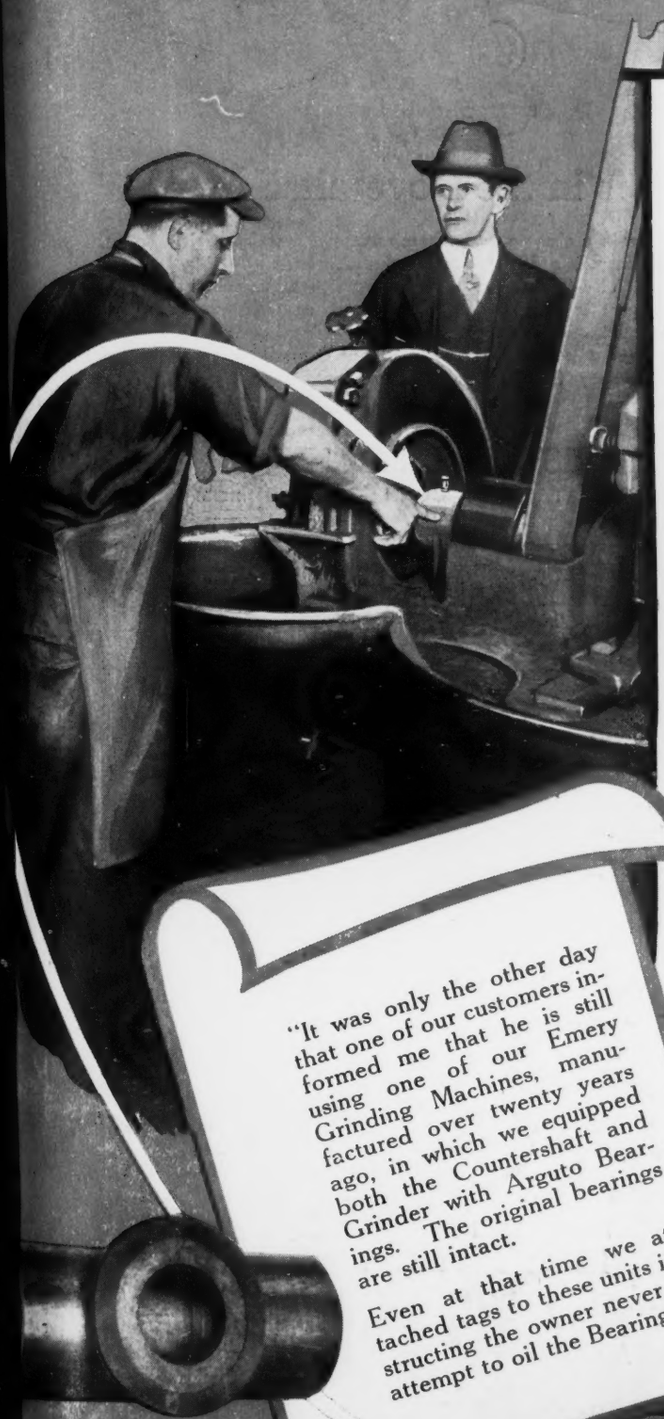

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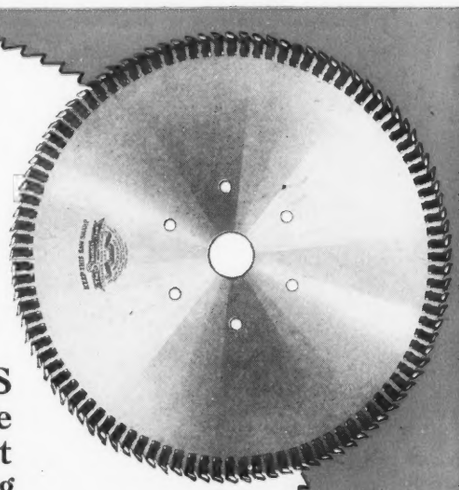

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MARCH MACHINERY 1924

How Automobile Tire Molds Are Made

Turning and Boring the Mold and the Form, and Engraving the Tread Design in the Mold

By CHARLES O. HERB

THE great ramifications of the automobile industry are appreciated by every man in the mechanical field. Many articles have appeared from time to time in MACHINERY relating to the making of parts for the engine, the differential, the wheels and axles, the steering gear, etc., all of which require highly developed machine shop methods. But nothing has been said about tires. Tires are made from rubber—a field entirely outside of that covered by MACHINERY; yet, even to produce automobile tires the very highest skill of the machine designer, toolmaker, and machinist has to be brought into play. Tires are made in molds. The molds are made from metal, and these metal molds have to be produced by very special processes, including intricate engraving methods. In the present article a brief outline is given of the manner in which molds and forms are used in tire manufacture, and the methods employed in machining and engraving these molds are described in detail.

Automobile tires are cured by vulcanizing in molds after they have been built up from the plies of cord or fabric and rubber of which they are composed. The building up of the tires is done on forms that approximate the outline of the inside of the finished tire. Cord-tire forms are collapsible to facilitate the removal of the built-up raw tire, which is then placed on a curing ring resembling an ordinary tire rim. Next a rubber air-bag is placed within the tire; this air-bag is similar in appearance to the inner tube used in automobile tires, except that it is made of considerably heavier rubber to withstand abuse. The tire, air-bag and curing ring are then placed together within the mold, after which the air-bag is filled with air. The effect of the air is to force the outside of the tire into all the mold impressions for the tread, and firmly against all other surfaces, during the curing process, and also to finish the inside.

The vulcanizing process is conducted at a temperature averaging 285 degrees for from thirty minutes to three hours, depending on the size of the tire. The position of that surface of the curing ring on which the tire seats, relative to the mold, is indicated by the dotted line in Fig. 2. For this process, the molds are lowered, one upon the other, into a pit furnace, deep enough to receive eighteen to twenty molds at one time. The molds are held in this furnace under a pressure of from 600 to 1150 pounds per square inch, which is exerted by a hydraulic ram to keep the two halves of each mold together.

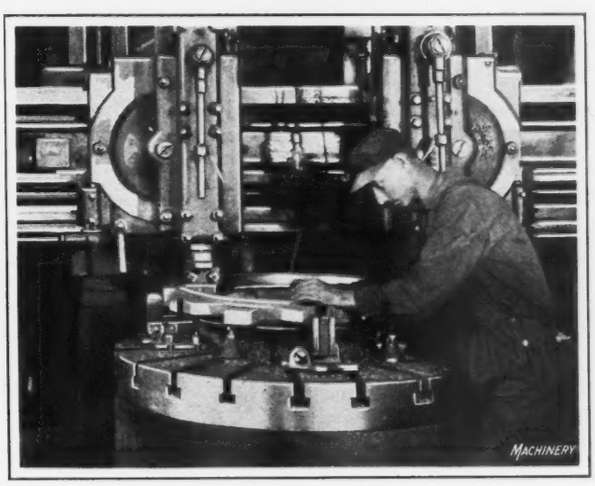


Fig. 1. Finishing a Tire-mold Half with a Form Cutter on a Boring and Turning Mill

Fabric tires are built up on non-collapsible as well as collapsible forms, and with the non-collapsible type, the form and tire are placed together in the mold for curing. In this case air is not used to force the tire into the mold impressions; the halves of the mold do not quite touch each other at the beginning of the process, as with cord tire molds, and hence as the rubber becomes heated, the pressure of the ram forces the halves together and squeezes the rubber into the impressions. The molds and

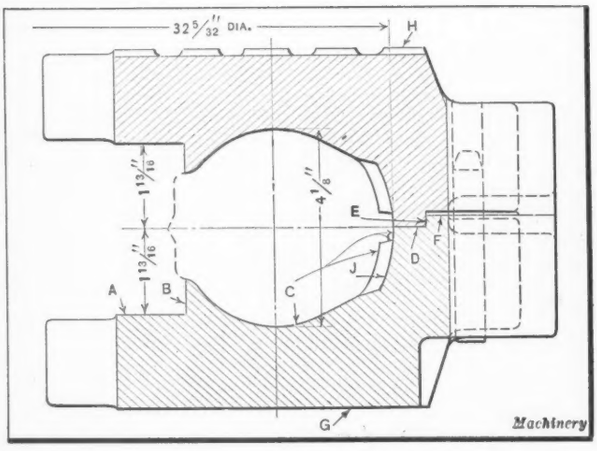


Fig. 2. Cross-sectional View of the Two Halves of a Mold for Cord Tires

forms of both cord and fabric tires are almost universally made from chilled iron castings, but cast-steel molds are used occasionally. The making of tire molds and forms, air-bag molds, and other similar tire-making equipment is practically all done on a jobbing shop basis, and comprises a small industry in itself.

Operations on the Turning and Boring Mill

Sectional views of a tire mold and form are illustrated in Figs. 2 and 4, respectively. This mold and form are both for cord tires. However, as their design is not radically different from those used for fabric tires, only the machining operations on the types shown will be considered. At the plant of the Reynolds Machine Co., Massillon, Ohio, the mold halves and forms are machined practically all over on Bullard and King boring and turning mills, after which the tread design is engraved in the mold halves on a special machine developed by this company, and the cord forms are split into sections. The dimensions on all surfaces that contact with mating parts have plus or minus limits of 0.003 inch, which indicates an accuracy that, off-hand, would not be considered necessary for work of this sort.

After a tire mold half has been carefully centralized on the table of a boring and turning mill, roughing cuts are taken on surfaces *A*, *B*, *D*, *E*, and *F*, Fig. 2, several of the cuts being taken simultaneously. A plain round-nose tool is also fed by hand to approximately the outline of surfaces *C*. Then finishing cuts are taken on surfaces *A*, *B*, *D*, *E*, and *F*, after which the tire outline about surfaces *C* is finished by means of a form cutter, such as illustrated diagrammatically at *A*, Fig. 5. This cutter is made from tool steel, 1 inch thick, and is dressed to about ⅞ inch thick. Surface *J*, Fig. 2, represents the depth to which the tread or skid design is later engraved. One of the important requirements of cord tire molds is that there must be a continuous metal-to-metal contact along surfaces *D* and *E*. After the adjacent surfaces of the molds have been machined, surfaces *G* and *H* are also finished.

Generally the tire company for which the molds are being made furnishes two templets—a master and a transfer. The latter is supplied to the jobbing shop as a standard to which the mold outline must conform. Templets are made by the Reynolds Machine Co. itself when tire manufacturers do not furnish them, so that work can be duplicated any time in the future without delay or confusion.

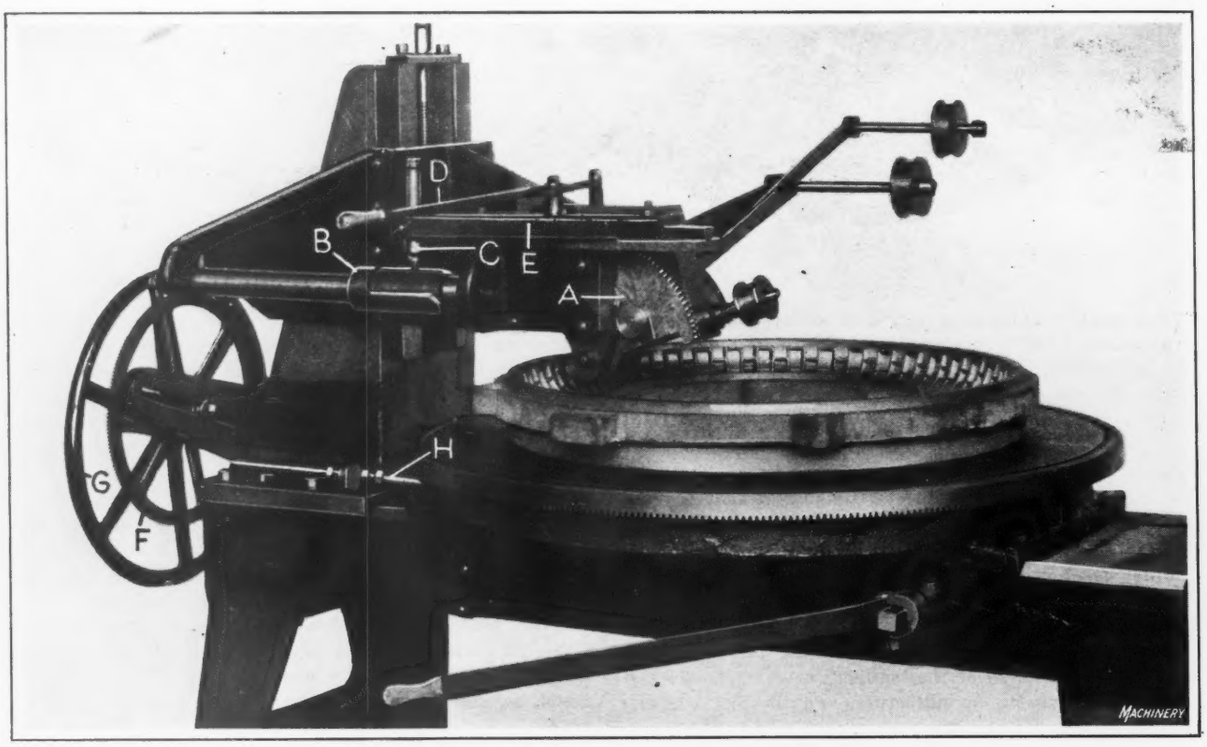


Fig. 3, Machine used in engraving the Tread Design in Tire Molds

The forms are finished all over on the same machines, a number of roughing cuts being taken simultaneously on the different surfaces, and the rounded outline *A*, Fig. 4, being

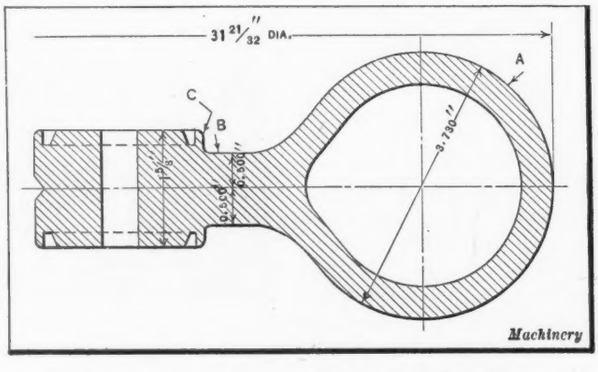


Fig. 4. Section of Form on which the Tire is built up

rough-cut with an ordinary tool. After the surfaces at the inside have been finished, surfaces *A*, *B*, and *C* are finished by employing a form cutter of the type shown at *B*, Fig. 5. When the surfaces on one side of the form have been rough-turned and faced, the work is reversed on the table of the machine for roughing the opposite side. Then this side is finished and the work again reversed for finishing the first side. Plus or minus limits of 0.003 inch are also specified on the important dimensions of the forms. The mold section illustrated in Fig. 2 is used in producing a 31- by 4-inch tire, and the form shown in Fig. 4 for a 32- by 4½-inch tire.

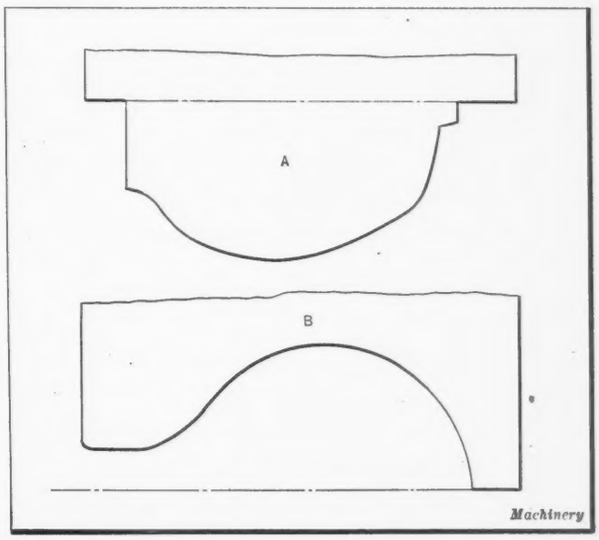


Fig. 5. Outlines of Cutters employed in finishing Molds and Forms

Engraving the Tread Design

Quite a few engraving machines have been developed for cutting the tread design in tire molds. These machines generally operate on the pantograph principle, the design of the tread being traced from a model of some sort that is made on a scale several times the size of the tread design itself so as to reduce any errors to a negligible quantity. The model usually has only one complete division of the design, the tread being produced around the entire mold by indexing the table of the engraving machine. In Fig. 3 is shown the Breitenstein engraving machine built and used at the Summit Mold & Machine Co., Akron, Ohio, and in Fig. 7 are illustrated several tread designs that have been produced on this machine, the impression in the molds being, of course, exactly opposite to the design on the tires. From eight to ten hours was required for cutting the designs in Fig. 7 on half a mold for a 33- by 4½-inch tire.

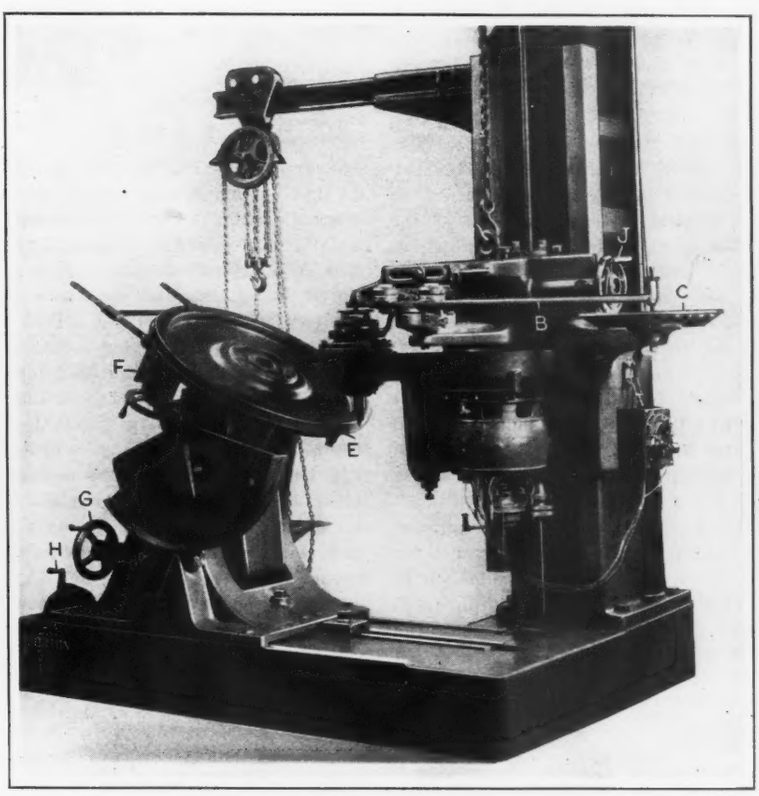


Fig. 6. A Larger Self-contained Machine for engraving Tire Molds

In this machine, a small two-fluted end milling cutter, about ¼ inch in diameter, and running at about 2300 revolutions per minute, is held in head *A*. The cutter may be swung at any arc or moved in a straight line to provide for machining both round and flat surfaces. The cutter movements are controlled by means of the round model or "profile cylinder" *B* (which is machined to suit the design required in the mold) and a pilot-pin *C*. The profile cylinder must be changed, of course, to suit each different tread design that is to be produced. The reduction is generally 2½ to 1.

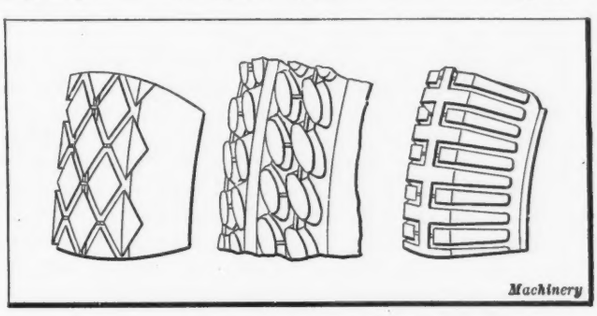


Fig. 7. Three Tread Designs for Automobile Tire Molds

Movements of the cutter-head are produced by pulling handle *D* back and forth. The handle is pivoted on a bracket mounted on the column, which is attached to carriage *E*. Pilot-pin *C* is mounted on the carriage, and is moved with it as the handle is manipulated. On the under side of the carriage there is a rack which meshes with the gear segment on head *A*, and as the cutter-spindle is held in a unit that is ordinarily locked to the segment, the cutter is swung back and forth with the segment in cutting curved surfaces. The cutter-spindle is rotated by the small pulley shown on its outer end, the belt to this pulley first passing over idlers. In cutting flat surfaces of the tread design, as on the sides of the tread, the gear segment swings, but the remaining parts of the head, including the cutter-spindle, are released from the segment and simply slide back and forth.

The indexing of the table and work is controlled by means of the profile cylinder. The shaft of this cylinder is connected through change-gearing *F* to a shaft running longitudinally through the column, which drives the table by means of a pinion and a large ring gear mounted around the table. Handwheel *G* is mounted on the forward end of this shaft, and is turned by hand to bring the various guiding surfaces of the profile cylinder against pilot-pin *C*. The ratio of the change-gears must always be such as to insure the correct relative movement between the profile cylinder

and the table. When one division of the tread has been completed, the pilot-pin is simply brought to the front end of the cylinder and handwheel *G* is turned to index the table for a subsequent division. The profile cylinder is usually made up for engraving one division at one revolution. The operator moves handle *D* back and forth with one hand, to guide the pilot-pin along the profile cylinder, while his other hand is kept constantly on the handwheel to hold the cylinder against the pin.

The engraving cutter can be adjusted relative to the head to change the radius of the cut, and there is a vertical adjustment for the head-and-carriage bracket. The platen on which the table rotates may be adjusted horizontally on the bed through a rack and pinion mechanism to suit the work. This adjustment also permits of moving the table forward sufficiently between the machining of different divisions, so that the work can be conveniently brought into position for the next division without having the tool cut through the ridges of metal in the design. A micrometer stop at *H* governs the distance from the face of the column to the surface of the mold being machined.

In setting up work on the table, an indicator is mounted on the side of the head, and applied along the internal surface of the mold as it is rotated, to insure that the mold is central on the table. The indicator is then applied to the top of the mold as it is rotated to determine whether the top is in a true horizontal plane. When cast-steel molds are being finished, lubricant is delivered to the cutter.

Another Type of Engraving Machine

A much heavier machine, weighing about 18,000 pounds, is built by the George Gorton Machine Co., Racine, Wis., for engraving tire molds as well as other parts. This machine, which is illustrated in Fig. 6, also operates on the pantograph principle. A tracing style at one end of the pantograph is used to follow an accurate "copy," three times the size of the design to be engraved, and this causes the engraving tool to make an accurate reproduction of the copy on the mold. A close-up view of an operation is shown in Fig. 8. The cutter-head frame pivots in a horizontal plane on the heavy swinging link *A*, Fig. 9, this link being fastened to the sliding head on the column. The pivot action permits the cutter to follow the movements imparted through the pantograph arm *B*, Fig. 6, from the copy which is secured on table *C*. The copy is usually made of brass or steel.

Because the surface of the tire mold that is to be engraved is concave, it is evident that means must be provided for moving the cutter vertically through an arc, in addition to moving it horizontally. This vertical movement is imparted to the spindle by having a point at the upper end of the spindle always in contact with the surface of a hardened

Fig. 8. Close-up View of a Tire-mold Engraving Operation

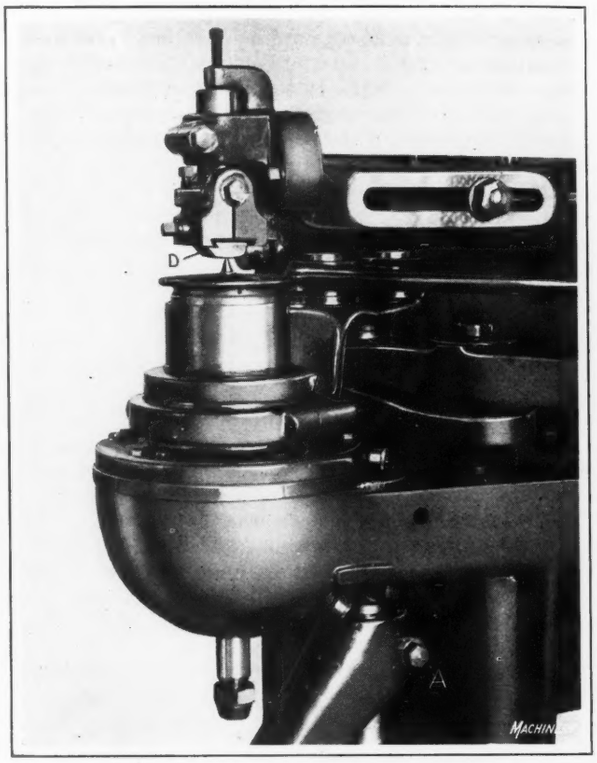


Fig. 9. Construction of the Cutter-spindle Head

convex piece *D*, Fig. 9, which has an outline exactly opposite to that of the surface being engraved. Thus no matter in what direction the cutter is swung by the pantograph mechanism, it is raised or lowered by piece *D* to suit the mold. The cutter-spindle is driven by a three-horsepower variable-speed motor, mounted on the same frame as the spindle head so as to swing with it. The speed of the cutter-spindle ranges from 950 to 1900 revolutions per minute.

The tire mold is seated on a faceplate *E*, Fig. 6, which is indexed for engraving the various divisions of the design around the mold. The faceplate is mounted on a heavy rotatable spindle, and may be of any required shape or size. Indexing is accomplished by means of a hand-operated mechanism located at *F*. After a mold has been placed on the faceplate by the use of the overhead hoist, it is centered and clamped in place. The faceplate is then tilted to the proper angle for the operation, which depends upon the design of the tread or the position of the letters to be cut. This angular setting is obtained through handwheel *G*, and the range of adjustment is from the vertical to about 15 degrees less than the horizontal.

In engraving a tire mold, the operator feeds the cutter into the work to the proper depth through handwheel *J*, and traces the master copy by means of the tracing style at the end of the long pantograph arm *B*. When a division of the design has been finished, the cutter is raised to clear the work, and the work indexed for the next setting, after which the cutter is again fed into the work and the tracing repeated. This cycle is followed until the entire mold is finished. This cutter is also of the two-flute type, and about ½ inch in diameter.

The engraving machine used in the plant of the Reynolds Machine Co. is of a special design which also operates on the pantograph principle and uses flat profile plates. In this plant, it is the practice, after engraving, to blend fillets into other surfaces, remove cutter marks, produce small fillets, etc., by means of a small air hammer, employing routing and similar tools, and hand scrapers. The marking of all molds is done by hand and requires a skilled mechanic. The heading illustration shows a workman engaged in putting these finishing touches on tire molds.

Tumbling and Burnishing

By B. G. KRAUSE, Assistant Sales Manager, The Globe Machine & Stamping Co., Cleveland, Ohio

TUMBLING is a process of cleaning, smoothing, brightening, and polishing parts by frictional contact with each other or with some material while the pieces are rotating in tumbling barrels. The tumbling process is also used for a variety of other purposes, such as japanning, painting, and plating metal parts and coloring wood and cork. Tumbling barrels vary in shape, size, and design, but the process in general is the same, although modified according to the type of work and finish desired. Barrel burnishing really comes under the broad definition of tumbling, although the process differs and accomplishes a different result. The usual action of tumbling is to remove or cut away burrs, fins, scale, oil, and flash from parts to obtain a smooth surface or edge; whereas barrel burnishing is done to finish, polish, or brighten metal parts without cutting away the stock. In hand burnishing, the object is to give a high polish to metal parts by rubbing with a burnishing tool. In barrel burnishing, the steel balls act as individual burnishing tools. Pieces that require sharp edges when completed do not lend themselves to tumbling.

Types of Tumbling Barrels

There are two general types of tumbling barrels—oblique tilting and horizontal. They are furnished with steel, cast-iron, cast-brass, and wooden shells, depending on the work to be tumbled. The tilting barrels are used for a greater range of tumbling than the other types. They customarily have a narrow mouth opening, and a wide closed bottom, and may be used for both wet or dry tumbling, but usually not for parts over 6 inches in length. For large or long pieces, or articles having heavy rough surfaces which must be removed by a coarse abrasive, the horizontal type is preferable. Large iron, malleable, steel, aluminum, and brass castings and forgings are ordinarily tumbled in horizontal barrels which have hollow axles, connected to an exhaust fan to draw away the dust. From fifty to one hundred pounds of castings can be tumbled at one time, but only those of a similar character, design, or weight should be tumbled together. For the general run of work, a barrel with a steel shell is preferred, as it withstands hard usage much better than other materials. For wet tumbling, a cast-iron shell is preferable, and for tumbling plated articles or soft metal parts requiring a gentle motion, a wooden shell is preferable. Cast-brass shells are used when pieces are tumbled in acid.

One outstanding advantage of the tilting barrel is that the operator can keep a close watch on the work and take out samples for inspection from time to time, without stopping the machine. The degree of the tumbling action can be made greater or less, that is, more vigorous or more gentle, by changing the angle of tilt. This type of barrel can easily be filled and emptied by tilting the shell either up or down, while the machine is idle or running. If large or long pieces are tumbled in a tilting barrel the parts will show a greater wear at the lower end and tend to become rounded. The amount of roundness depends upon whether the parts are hard or soft, hollow or solid, and upon the angle at which the barrel is tilted.

Tumbling Mediums or Materials

Many materials are used in tumbling, the medium depending upon the work and the finish desired. The action of the mediums ranges from a mere rubbing to an appreciable grinding. A few of the mediums are hard-wood sawdust, gravel, pumice, steel slugs, sand, powdered emery, broken emery wheels, ashes, sandstone, rouge, leather scraps and meal, and tumbling jacks and stars. Water or diluted sulphuric acid is sometimes used for tumbling scaly pieces, or preparatory to some rustproofing operation. Such abrasives as emery, sand, and gravel are used both wet and dry, the liquid being either oil, water, or a special solution. After the parts are smoothed, they are often polished by rolling in hard maple sawdust, scrap leather, felt, and talc.

When tumbling operations are done simply to dry and clean parts from oil, grease, and water, sawdust is used and the gentle rubbing also brightens the work. Hinges, keys, and small metal parts, such as stampings and screw machine products, and black and lightly scaled parts, are also cleaned by tumbling with sawdust. Flash and burrs can be removed from brass and steel parts, by using steel slugs and sawdust as the tumbling medium, a suitable proportion being two shovelfuls of sawdust to one of slugs. Flash is sometimes removed by tumbling with white sand, gravel, or emery. Sand can be cleaned from brass castings by the use of brass scrap and water. For smoothing and polishing pawls, studs, and miscellaneous metal work, fine sand and ashes can be used.

When parts are to have fairly clean surfaces and a good bright finish is desired, leather scrap or meal free from tannic acid should be the tumbling medium, and enough so used that a cushion will be formed where the work falls back against the shell of the barrel. Steel balls or similar articles can be polished and finished by placing them in a wooden horizontal or tilting barrel for two operations. The first operation should be one of smoothing by tumbling the parts in a Vienna lime mixture, and the next should consist of tumbling the parts in scrap leather, free from tannic acid. These operations give the parts a high luster or polish without cutting away stock. Sometimes in getting parts ready for plating, when it is only necessary to clean off the grease and oil, hot water and alkali is the tumbling medium.

Ball Burnishing Practice

Tilting barrels are sometimes used for ball burnishing when the work is small, but the horizontal type is universally recommended. The hardened and polished steel balls roll over the work while under pressure, and rub against the parts evenly. The pressure is caused by the weight of the balls and the work in the barrel. Some manufacturers claim that a horizontal barrel, large in diameter and comparatively small in width, is the best type to use, because a certain quantity of balls will not spread over so large a space, and will therefore create a greater pressure on the work. In this type of barrel, about two pecks of steel balls should be used for one peck of work, and to this should be added a sufficient quantity of soapy water to rise one inch above the contents of the barrel. Soapy water serves as a lubricant. About six ounces of pure soap or soap chips without much alkali should be put in each pail of water. Another manufacturer claims that a barrel of small diameter, and comparatively long, completely filled with work, balls, and soapy water, is more efficient than the type just mentioned. It is said that the work then passes constantly and evenly through the mass of balls without bumping and falling against each other.

Polygon-shaped barrels prevent the work from bunching together and sliding instead of tumbling inside the barrel. Balls from 1/16 to 1/4 inch in diameter are generally used, the size depending on the work and dimension of the cavity

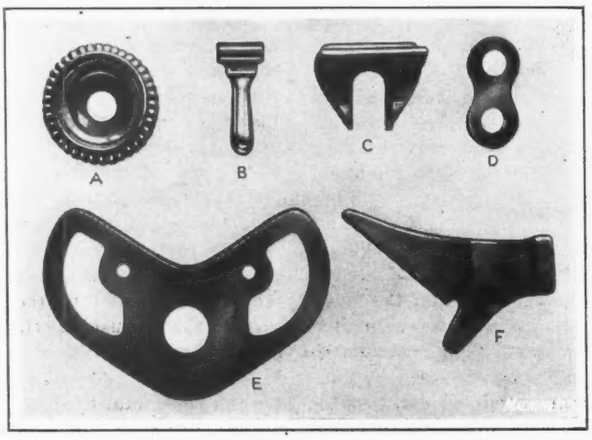
or corners in the pieces; the balls should be small enough to enter all cavities, and to insure this, a round steel slug with a fin-like edge is sometimes used. Articles to be barrel-burnished must be cleaned and must be free from oil or dirt. Double and triple burnishing barrels permit of burnishing more than one class of work at a time. The advantages of burnishing barrels are obvious; their use permits the finishing of hundreds and thousands of small pieces at one time quickly and inexpensively.

Plating and Japanning

For nickel-, brass-, copper- and zinc-plating small articles in quantities, a tilting tumbling barrel equipped with a wood shell and cathode and anode connections may be used, the articles being hung on wires. As the barrel revolves, the work is subjected to a tumbling action which gives it a bright luster. The ease with which the barrel can be loaded and unloaded, and the easy inspection of the work while being plated are advantages of this type of equipment. In japanning small nuts and washers, about two hundred pounds can be dumped at a time into a tilting barrel with about one-half pint of japan and tumbled until the pieces are thoroughly covered and almost dry.

Examples of Work Suitable for Tumbling and Burnishing

Parts having fairly continuous surfaces, such as are here illustrated, are well suited for tumbling and burnishing. The smallest of these parts—casting *B*—is approximately 2 inches long, while part *E* is about 5¼ inches long by 3½ inches wide. The practice followed in tumbling and burnishing these parts will be briefly described. Part *A* is a brass lighting fixture received rough and unfinished from the foundry. Because considerable stock must be removed and the casting cleaned up, the first operation of tumbling is performed in a horizontal barrel with sandstone and water, until all roughness has been removed, and the parts are then dipped in water to wash off the sand. They are next given a preliminary burnishing by tumbling with steel balls and soapy water, after which they are brass plated. They are then returned to the burnishing barrel and rolled with steel balls, but for a shorter length of time than in the preliminary burnishing. Finally, they are tumbled in hot sawdust for the purpose of drying.



Examples of Parts conveniently cleaned and polished in Tumbling and Burnishing Barrels

Part *B* is a brass window raiser such as is used in closed automobiles. The tumbling and burnishing operations for this part are identical with those just described. Sometimes, when the parts are not bright enough after the burnishing operation, they are momentarily dipped in a solution of equal parts of nitric acid and sulphuric acid. Part *C* is an automobile tire-rim clamp that must be thoroughly cleansed of scale prior to galvanizing or sherardizing. The clamp is first pickled, and then tumbled with sawdust in a tilting barrel until it is dry, clean, and has a slight luster. These clamps could also be cleaned of scale by putting them in a tilting barrel filled with a solution of sulphuric acid and water, and tumbled until the scale is removed. After galvanizing, the parts could again be tumbled in sawdust for drying.

Part *E* is a control sector for an automobile, and comes from the punch press oily and covered with burrs. It is put in a tilting barrel and tumbled with sawdust until the burrs are removed and the part cleaned, about one hour being required to reach the desired degree of finish. The chain link shown at *D* is also a stamping and is treated in about the same manner as the sector. Part *F* is a malleable iron casting used on textile machinery. It is smoothed and cleaned by tumbling in a horizontal barrel with sandstone and water.

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INDUSTRIAL DEVELOPMENT OF THE WEST

The industrial development of the Pacific Coast is referred to in a recent number of *Commerce Monthly*. It is expected that in the next fifty years the Pacific Coast, from Seattle to San Diego, will be transformed into an industrial region similar to the Atlantic Coast from Portland to Baltimore. In 1919, the manufacturing output of the Pacific Coast states was valued at $3,000,000,000. Since that time there has been a considerable increase in the manufacturing capacity of the plants on the Coast. Compared with the total production of the manufacturing industries of the United States, the Pacific Coast states produced, in 1921, 5½ per cent. The depression in 1921 was felt less severely on the Coast than in other parts of the country, and while the value of manufactures in the United States declined 30 per cent from 1919 to 1921, the decline on the Pacific Coast was only 23 per cent.

The population of the Pacific Coast is 5.4 per cent of the total population of the United States, which indicates that, as a manufacturing section, the Pacific Coast now produces manufactured products at the same ratio to population as the remainder of the country. The 1920 census indicates, however, that the machine-building industry is, as yet, comparatively unimportant in this part of the country, and that of the major industries only the shipbuilding industry employs a large number of machine tools. There is a great demand, however, for woodworking machinery and for machines used in canning and preserving fruits and vegetables, flour milling, and packing-house machinery.

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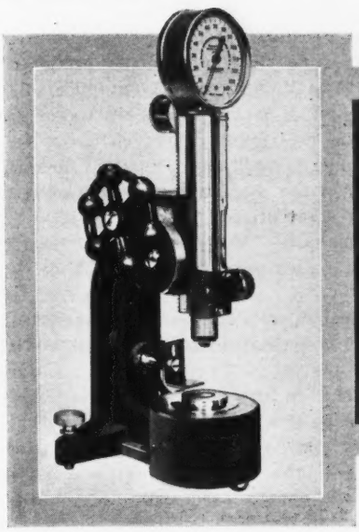
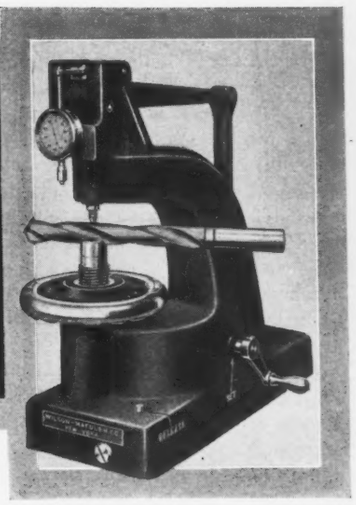
GERMAN COMPETITION DIMINISHING

In a communication from Consul M. K. Moorehead, of Stuttgart, Germany, recently published in *Commerce Reports*, the fact is emphasized that German competition in the machinery field is diminishing. It is pointed out that articles appearing in newspapers and magazines in recent years have indicated that German manufacturers held a position of advantage in the world's markets because of the depreciating value of the mark, and in frequent instances these reports have been of a character to discourage American manufacturers from making serious efforts in foreign markets. Information has now come to hand, however, which shows that these reports have been exaggerated, for the trade returns covering recent years indicate that German exports of machinery since the armistice have never equaled the pre-war volume.

In this connection it should be remembered that in pre-war years Germany furnished possibly 45 per cent of the machinery entering international trade, and it would appear that American manufacturers of engineering equipment have an unusual opportunity in soliciting the business that Germany no longer can accept. For some little time longer it is to be anticipated that we will receive reports indicating that German manufacturers are offering machinery at absurd prices, but it would also appear that the day is fast approaching when competition of this kind will disappear, and manufacturers are justified in modifying their export plans correspondingly.



Definitions of Hardness



By CLARENCE A. BECKETT
Columbia University, New York

FOR a number of years the subject of hardness has held the interest of a diversified group of experimenters, including physicists, metallurgists, and engineers. This group is divided into two classes—one is interested in the process of hardening and the other in the development of a hardness testing or measuring instrument. A number of hardness definitions and methods of determining hardness, as defined or employed by various experimenters, will be given, in order, possibly, to clarify the true meaning of hardness and eventually establish a universal definition.

Wear—Scratch Hardness

Dr. H. P. Hollnagel, in his paper on the "Significance of Hardness Tests," presented before the American Society for Steel Treating, defines hardness and its allied properties as follows:

"Hardness has been defined as the resistance to wear, determined by the amount of material removed as measured in thousandths of millimeters; the degree of hardness is thus fixed if the given materials are worn off under fixed load in proportionate times."

Perhaps the oldest of the hardness terms is known as "scratch hardness," which characterizes the property or quality whereby one material abrades another, the scratched material being less hard. For the mineralogist the Moh scale is standard. In this scale, relative degrees of hardness are indicated by numbers; thus the diamond is 10, sapphire, 9, gypsum 2, and talc, 1. The higher the number, the harder the mineral.

Rebound—Crushing—Bending

In the ball bearing industry, the height to which the specimens rebound, when dropped upon a fixed plate properly hardened, has been adopted as a measure of hardness. Still another test makes use of the crushing of the specimens themselves. In this case the fracture is examined microscopically and the hardness judged therefrom.

For wires and small sectional specimen, the resistance offered to bending is often taken as a measurement of hardness. In such cases, it is customary to determine the number of reversals to which a given specimen may be subjected without rupture, by bending through definite angles. The lower number the harder the material.

Penetration—Impact Hardness Test

Resistance offered by material to penetration is a common definition of hardness. It is preferable to use the term "penetration" rather than "deformation," as the latter should be reserved for another characteristic. In measurements of the type that requires the surface to be penetrated, it is necessary that the yield point of a portion of the material be exceeded. Further deformation beyond the yield point meets with resistance which is more than proportionately greater than the deformation. This resistance is defined by the writer as "deformation hardness." It is the resistance to deformation beyond the proportional limit and yield point of the material, and is the type of hardness usually measured by any of the indentation devices. Penetration through a surface only will determine superficial hardness. Penetration through a definite thickness of material, thereby causing permanent set, indicates a greater hardness, the degree dependent upon the heat-treatment to that depth. If the depth of penetration is further increased, a value of greater magnitude will also be obtained, depending entirely upon the depth of such indentation.

In the case thus far discussed, the outstanding physical treatment common to all is deformation of form. To be sure, deformation is not accomplished in exactly the same manner, and in most cases is attended by permanent set. There is the exception—the elastic resilience of balls—in which case permanent set rarely occurs. If there is permanent set, the test no longer is a measure of resilience alone.

Almost any impact hardness test is either of the resilient or semi-resilient type. A hardness test, as the term is usually applied, relates to permanent deformation. In such cases, hardness is at times defined as the energy expended per unit volume of the indentation caused by impact. This is an unfortunate concept, as resistance is force, and should not be misconstrued with energy which is its space integral. Since impact is usually accompanied by a rebound which depends upon the rate at which the compression wave travels into the specimen and upon the impacting medium, rebound may be defined as a function of the duration of impact.

Time as Related to Hardness Testing

In general, no restrictions are placed on the time of application of the stresses. One might conclude from this that time is of no consequence in hardness testing. A simple consideration of the time required to accelerate masses to a given velocity, however, shows that time is very important, even though such masses be of molecular magnitude. A force constantly applied for a considerable time should ultimately penetrate farther into a material of given hardness; other things being equal, than one having the same momentum, but acting for an infinitely short interval. The latter force might well surpass, by a very great margin, the proportional limit and yield point, and the material not show signs of rupture.

Various Definitions of Hardness

Professor A. H. Tutton, a crystallographer, says that the hardness of a solid substance may be defined as the resistance offered by a smooth surface of the substance to abrasion.

Sir Robert Hadfield states that hardness, as ordinarily defined, is the resistance to penetration. In general, a greater resistance is offered by a material already deformed

than by the same undeformed material during the first permanent deformation. That is to say, there is a natural hardness and a deformation hardness.

The definitions of hardness given by H. M. German follow: "Hardness is the ability to withstand abrasion or resist penetration. In recent years, there has been a tendency to apply more specific terms to steel; thus, *initial hardness* is the hardness obtained by quenching; *temper hardness* is the hardness obtained by tempering initial hardness; *case hardness* is the hardness of the surface of steel obtained by carburizing and quenching or caused by overheating in grinding; *red hardness* is the property that a cutting tool has of retaining its hardness when operating at a red heat."

Dr. W. H. Hatfield, in a paper read before the Iron and Steel Institute, 1918, defined hardness as the resistance of a piece of solid material to penetration by a steel ball under a static load.

Zay Jeffries and R. S. Archer, in their paper presented before the American Society for Steel Treating, gave a general definition: "The terms 'hardness' and 'strength' connote a number of more specific physical properties. The most definite of these is the proportional limit or, what is practically the same thing, the elastic limit. The common measure of the strength of a material is its tensile strength, or the maximum intensity of tensile stress endured before rupture, calculated on the original area of the test piece. This is obviously a more complex property than elastic limit. Hardness may mean resistance to indentation, as measured by the Brinell test; resilience, as measured by Shore's scleroscope; scratch hardness; cutting hardness; resistance to machining; or some other special kind of hardness. All of these properties may be embraced in the general definition: Hardness is resistance to permanent deformation."

Hugh P. Tiemans in the "Iron and Steel Encyclopedia" gives the following definitions: *Hardness*: The resistance offered by a body to abrasion or penetration; *Natural Hardness*: The hardness of a material as ordinarily made without any special additional treatment; *Glass Hardness*: The highest degree of hardness attainable by steel, in which condition it can scratch glass, but as the hardness of glass may vary, it has been suggested that *Flint Hardness* be substituted; *Hammer Hardness* or *Rolling Hardness* is the effect produced when heated metal is worked below its critical temperature; if the temperature drops to a point corresponding to a blue temper color (blue working), the metal may be rendered brittle, which condition is known as *Blue-Shortness*."

Dr. H. O. Hofman, in his "General Metallurgy," gives the following concept of the subject: "The word hardness as applied to a metal is used to express five ideas: the resistance it offers (1) to scratching (scratch hardness); (2) to indentation (indentation hardness); (3) to elastic impact (rebounding hardness); (4) to cutting (cutting hardness), and (5) to permanent deformation (tensile hardness)."

H. Hertz first defined hardness as the mean pressure which exists at the center of the indentation when the material under test has just reached its elastic limit. This definition he applied only to bodies that have surfaces of such a form that a circular indentation results when they are pressed together. Hertz confined his hardness measurements to glass and similar brittle substances in which the attainment of the elastic limit is denoted by the appearance of a circular fissure around the contact area. Such a fissure does not necessarily denote that the material at the center of the indentation has passed its elastic limit. Hertz has shown that it is impossible to apply his definition to metals, because there is no means of telling when the elastic limit is reached at the center of the indentation. It is, however, interesting to compare Hertz's definition with Brinell's definition for the Brinell hardness numeral. Brinell defines the hardness numeral as the ratio of the pressure on the sphere to the area of the spherical indentation produced.

Bradley Stoughton, in "The Metallurgy of Iron and Steel," states that the hardness of a metal is its resistance to scratching or to wear due to friction.

Ernest Pull, in his "Modern Work-shop Practice," defines hardness as "the property of the surface of a metal to resist penetration by cutting or scratching."

Professor G. F. Charnock, in "Mechanical Technology," defines hardness as "the resistance offered by a body to penetration."

G. W. Danforth, in "Mechanical Processes," defines hardness as "the property of resisting change of shape under pressure."

Carpenter and Diederichs, in their "Experimental Engineering," define the hardness of a material as follows: "The hardness of a material is usually understood as a relative property having reference to the ability of one material to cut another. Hardness is a composite property, depending partly on density and on tensile and shear strength."

E. Meyer (Zeitschrift des Vereines Deutscher Ingenieure) defines the ball test hardness as "the mean pressure upon the unit area of the impression circle, that is, upon the unit area of the projection of the spherical impression."

Professor H. L. Parr's definition is as follows: "The term hardness is so generally used, and may mean so many different things, that any definition given will not be completely satisfactory; however, inasmuch as hardness has been assumed to be proportional to a load necessary to produce a constant sized impression, "hardness" may be defined as the resistance offered by material to penetration or the ability of material to withstand abrasion."

The "Metallurgists and Chemists' Handbook," compiled by Donald M. Liddell, gives the following: "The customary hardness test at the present time is that of Brinell, which consists in making on a flat surface of the material an indentation by means of a small steel ball applied under known pressure. According to Rosenhain, perhaps the best definition of hardness is 'the power of resisting local displacement of portions of the surface.' But it is at once evident that this power is by no means a simple and definite property of the material which will reproduce itself in all circumstances. Thus the displacement of a portion of the substance of a material may occur by plastic flow—the material may be indented at one point while its level is raised at other points; in other circumstances or in other materials, the displacement may occur by direct fracture, as in the scratching of a brittle material. Either of these forms of local displacement may be brought about by the application of a steadily increasing force or by a rapidly applied force, that is, by a shock or blow. It is by no means certain that the power of resisting all these various forms of displacement will be identical or even proportional, so that the material which displays the highest scratch hardness is not necessarily the hardest under an indentation test."

A text-book of physics, edited by A. Wilmer Duff, states: "Hardness is a term used in different senses. It sometimes means the opposite of plasticity, that is, resistance to change of shape, as when we speak of iron as hard and rubber as soft. Another use of it is to denote power of scratching, as in the mineralogist's scale of hardness, which consists of a series of substances with diamond at one end and talc at the other, arranged so that each, beginning with the diamond, will scratch the following but not the preceding."

Dr. Le Roy C. Cooley, in his book on physics, defines hardness as the property of a solid by virtue of which its substance is not easily worn away or abraded.

Ledebur says, in "Stahl u. Eisen," 1894: "The term hardness may be understood to apply both to the resistance of a body to shaving (or drilling) and to its brittleness, as evidenced by the material when its resistance is tested in any manner and deformation occurs. Hardness is related

to brittleness, and common usage makes brittleness the reverse of toughness; therefore it might be inferred that a tough body cannot be hard, but manganese steel is so tough and flexible that it may be tied into a knot, but it is so hard that it cannot be cut by machine tools."

Reiser, referring to Ledebur, defines hardness as "that resistance of a body which it offers to penetration by another solid—as in drilling, sawing, or filing—or opposes to permanent deformation by crushing or tension. The elastic limit rises with increase of hardness, so that material having high elastic limit also shows considerable hardness. If in this case the limit of elasticity and maximum resistance are close together, the material will be hard and brittle, as white pig iron; if, however, these two limits be widely separated, the body will be hard and tough."

Professor Adolf Martens, in his "Handbook of Testing Materials," states: "The hardness of a material is a property which the constructor frequently utilizes, sometimes valuing it highly, although but rarely attempting to measure it. The most common definition is: 'Hardness is the resistance opposed by a body to its penetration by another body.'"

Because the electrical conductivity, the magnetizability, the permanence of magnetism, hysteresis, and other properties are dependent upon chemical composition, and as these vary in a manner parallel to hardness, v. Waltenhofen, v. Kerpely, Barus, and others are inclined to define and grade hardness (of iron) by its electric, its thermoelectric, or its magnetic behavior.

According to Professor D. E. Hughes, the magnetic capacity of iron and steel is directly proportional to the softness, and the resistance to a feeble external magnetic force is directly proportional to the hardness, the electric conductivity of steel decreasing with increase of hardness.

F. E. Cardullo, of the G. A. Gray Co., at the last annual meeting of the American Society of Mechanical Engineers, offered the following definition: "Hardness is a property of material which is proportional to the product of the elastic limit and the modulus of elasticity." According to Mr. Cardullo: "Hardness is not a property which has hitherto been measured by any method involving the fundamental units of mass, force, length, and time, the property being regarded as a purely comparative one. In the application of the scratch hardness method of comparison, arbitrary hardness numbers are assigned to certain materials of uniform hardness, and other materials are compared with them by scratching or filing. In the application of the pressure hardness method, a sphere or other geometric form is forced into a surface under standard condition, and the hardness is assumed to be proportional to the pressure, and inversely proportional to the area or else the depth of the indentation produced. Pressure hardness is roughly proportional to the compression elastic limit of the material. This is the principle of the Brinell and Rockwell tests. In applying the rebound hardness test, a suitable hammer is dropped on the material under such conditions that a part of the kinetic energy of the hammer is expended in crushing the material and the remainder appears as energy of rebound. The hardness is assumed to be proportional to the energy of rebound. This is the principle of the Shore scleroscope. The hardness so shown is a function of the compression elastic limit divided by the modulus of elasticity.

"Hardness connotes the idea of impenetrability. If two equal spheres be pressed together, that one is harder which is least deformed by the pressure. As the pressure is increased there finally comes a point when one of the spheres will be permanently deformed. If the pressure is increased beyond this point, both will be permanently deformed, the softer one more than the harder. The property which resists deformation is the stiffness of the material, and when measured in pounds per square inch, it is known as the "modulus of elasticity." A more correct name for this property would be 'coefficient of rigidity.' With equal moduli of elasticity, that substance is hardest which offers the greatest resistance to permanent deformation (that is, that substance that has the highest compression elastic limit). It therefore follows that the hardness of a substance is a property which is proportional to some function of its compression elastic limit and of its modulus of elasticity. The simplest function is, of course, the product of these two quantities, and this function is suggested as a suitable measure of hardness. So far as the writer knows there are no conceptions of hardness current among engineers, metallurgists, or mineralogists, which are incompatible with this definition of hardness."

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BETTER APPRENTICE TRAINING

By H. G. DOWNS

I have read MACHINERY for many years, and though there has always been much in the journal that has been of value and interest to me, one of the most vitally important articles that I have ever read is the one in the December number on "Worth-while Vocational Training," by George B. Frazee. It is with great satisfaction that I read of the efforts being made to provide adequate training and technical instruction for the future workers in the mechanical field, both in the shop and the drafting-room.

When I served my apprenticeship twenty-five years ago in one of the large machine tool building plants, I worked ten hours a day for four years in the shop, but little effort was made to aid me in obtaining the mechanical knowledge that I should have acquired. During my experience since that time I have come in contact with many machinists and found that more than half of them are unable to cut a special gear or an unusual thread without constantly asking questions of their fellow workmen or of the foremen.

The United States Navy maintains trade schools at great expense to the Government, to give proper training to machinists, but in civil life I find that with few exceptions the training conditions for apprentices are but little improved. Many machinists are capable and earnest, but unable to make the best of their opportunities because of lack of fundamental knowledge on mechanical subjects. I feel that these men would have been better able to fill their present places if systematic methods for training apprentices were generally in vogue in the machine shops throughout the country.

I have found in my mechanical journeys that after all boys are little men, and men are big boys, because both follow the lines of least resistance. They need to be aided and guided. Some of the boys who enter shops where they receive indifferent training eventually develop into journeymen who give speeds and feeds only such thought as is forced upon them, who let their books of reference, if they have any, lie in the back of their tool chests or at home, depending entirely upon index-plates for their calculations, and who never take the trouble to find out the reason "why." Meanwhile, they wonder why they do not get along any better at their trade.

I have learned, by constant observation, to judge a man, first, by the arrangement of his tools upon his bench or his machine; second, by the reference books that he has at hand and the frequency with which they are used; third, by the way he grinds his tools for different metals; and fourth, by the feeds and speeds he uses at different stages of his task. Last but not least, I judge him by the attention he gives to his own work and the extent to which he leaves his neighbor alone.

Summing up, I believe that "worth-while vocational training" is the answer to the question "How can we get better mechanics?" I am sure that it is possible to induce bright, capable boys to learn the machinist's trade, if that trade is raised to a higher standard through conscientious and thorough training.

Constructing Strong Crates for Machinery

By C. A. PLASKETT, Forest Products Laboratory, Madison, Wis.

DURING the last few years a campaign has been carried on by numerous organizations throughout the country to obtain greater economy in the shipment of freight. The Forest Products Laboratory at Madison, Wis., and many other organizations of national scope have endeavored during the last decade to determine the most efficient containers for the shipment of different commodities, and to acquaint the manufacturers and shippers with the best methods of packing. Recently the railroads have initiated a very successful campaign to educate their employes in the proper handling of freight. As a result their loss and damage claims for 1922 were reduced to about half what they were before the campaign was started. However, the railroads cannot prevent all damage to goods in transit, and even with the most careful handling consistent with efficient transportation, there are always some lost or damaged goods. The goods must be packed to withstand reasonable hazards; otherwise the manufacturer cannot expect them to be received in good condition by his customer. The shipping of poorly packed goods involves a big risk of loss or damage, against which it is necessary that the railroads be protected by high freight rates.

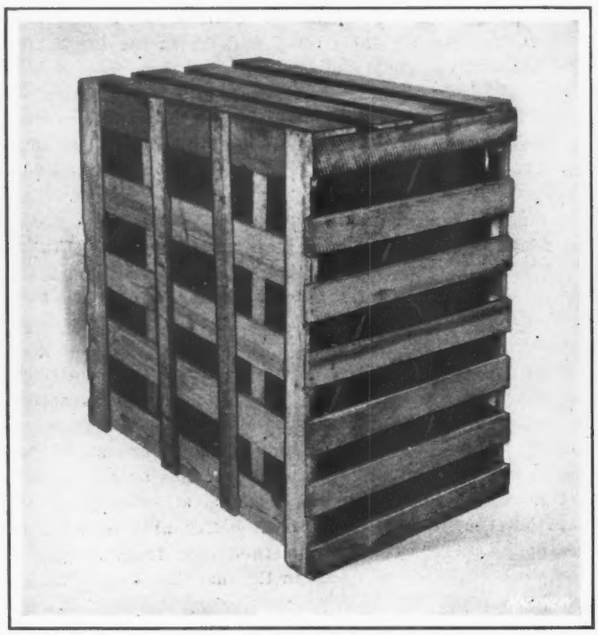

Fig. 1. Type of Crate originally used by a Manufacturer

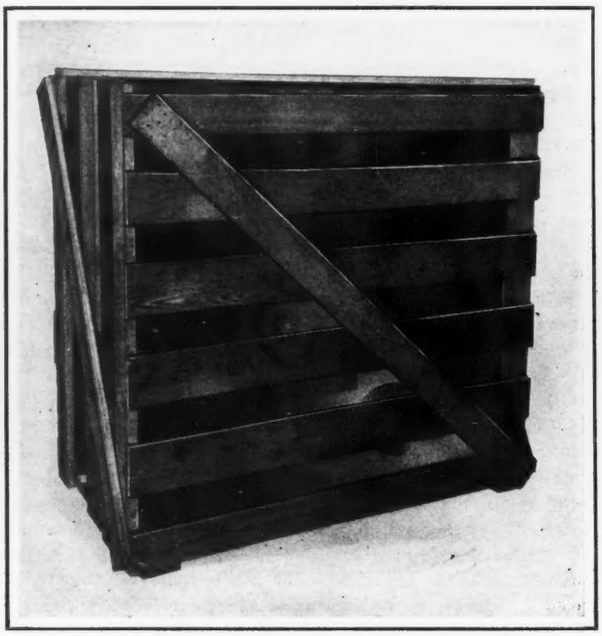

Fig. 2. Improved Crate developed to replace the One shown in Fig. 1

It is to the interest of every manufacturer, therefore, to pack his goods so that they will arrive in a satisfactory manner; but he should not be called upon to spend more money on packing than is necessary for safe delivery when the goods are handled with reasonable care. A properly crated product also creates a good impression on the purchaser, which has a considerable advertising value.

As a result of this campaign for better shipping containers, manufacturers, shippers, and consumers have all derived many benefits. Recently, many manufacturers and shippers have discovered that it is possible to reduce their loss and damage claims by the use of improved containers, thus relieving themselves and the railroads of considerable trouble and expense, and at the same time effecting a substantial saving in their packing and shipping costs.

Experimental Work on Packing Boxes

The promotion of scientific crating methods was started by the Forest Products Laboratory about thirteen years ago, at a time when the importance of employing more efficient crating methods was not so generally recognized. It was for the purpose of conserving the forests by developing better shipping containers with less lumber that the Forest Products Laboratory first directed its attention to container design. Tests on the physical and mechanical properties of more than 150 native species of wood, including hundreds of tests on timbers of structural sizes, have been made. In studying wooden joints, thousands of tests have been made on the holding power of nails, screws, bolts, and other means of fastening. Later, the methods of handling freight at receiving and shipping points were carefully studied, and the nature of failures at these points noted. It was concluded, however, that it was practically impossible to determine the exact cause of damage by the inspection of goods upon arrival at their destination. In order to design stronger and better crates, the laboratory developed a method of testing which would subject the goods to practically the same treatment that they received during transportation.

The first tests, which were made on packing boxes, consisted of applying a load along the diagonal of the box, thus producing, very slowly, stresses similar to those that occur when a box is dropped on one of its corners. Similar tests were made by applying the load on the edge or face of the box. Tests were also made by dropping the box in different ways from various heights. Other tests were made with a vibrating machine which imitates the swaying or weaving motion of a moving freight car and the starting or stopping of the train. Each of these tests shows the relative strength of containers when subjected to certain kinds of stresses which are more or less evenly distributed, but individually these tests do not show the ability of a container to resist a wide variety of stresses and none of

them show the ability of a container to resist local fracture caused by one box falling cornerwise on top of another.

A revolving hexagonal-drum testing machine was therefore developed, to provide a method of testing that would subject the crated machine to a great variety of transportation hazards. As the drum revolves, the crate rolls and tumbles in such a manner that it is subjected to stresses, shocks, and general rough handling similar to that encountered in actual transportation. On one face of the drum there is a projection upon which the crate falls, thus simulating the condition of one box dropping cornerwise upon another. For this test the container is loaded with its actual contents or a substitute that will produce the same effect on the container. Such tests are carefully watched at the laboratory and the development of failures traced. Improvements in the crate or package are then made with a special view to overcoming such failures. Laboratory tests of this kind have proved much cheaper and more practical than trial shipments.

Tests on Crates Submitted by Manufacturers for Investigation

In the case of nearly every box or crate submitted to the laboratory for testing, it was found that less lumber might have been used and the strength of the container increased by redesigning. The redesigned containers usually effect a considerable saving in weight and shipping space, with a resultant decrease in freight costs. After the laboratory tests have been completed, still greater benefits may be obtained if the containers are watched in service to determine whether or not the tests have faithfully reproduced in every detail the conditions of transportation.

Best Type of Crate Construction

Crates that are constructed with several parallel slats, as shown in Fig. 1, appear to be very strong, partly because of the amount of lumber used. This construction, however, is weak in resistance to weaving or skewing. It has been found that diagonal braces are the most efficient means of producing rigidity. In fact, unless proper diagonal bracing is used, it is practically impossible to build a crate that will not weave or skew during transportation without employing excessive amounts of material and labor. Diagonal braces on four sides produce a crate that is rigid in two directions, but not so rigid in the third direction. Neither does solid sheathing on all faces make a crate so rigid as does diagonal bracing, with the possible exception of a case when wide boards are used and care taken to have the joints tight. In such cases, however, there is a possibility of the boards shrinking and opening up in the joints. To produce a thoroughly rigid crate, diagonal braces should be used on all six faces. In some instances, this bracing may consist of a part of the machine being packed, as when the face of a crate is bolted to the base or other section of the machine which is capable of taking the stresses of transportation.

The frame members—that is, the foundation or skeleton to which all other parts are fastened directly or indirectly—and the method of fastening these members together are of utmost importance. Care should be taken to have these members made of good sound material. The three-way corner construction, which is now being used quite extensively, is a very satisfactory method of joining the corner members of a crate, but this construction alone does not produce a crate that will remain rigid during transportation. This construction, reinforced with a single diagonal brace on each of the six sides, as shown in Fig. 2, has been found to produce a crate having maximum rigidity for a minimum amount of lumber.

The method of constructing a crate best suited to a given machine depends upon the nature of the machine and the kind of protection needed. It is needless to use a heavy rigid crate on a machine that is itself strong enough to withstand the rough handling of transportation. Such a machine requires merely a snug-fitting crate to protect it from blows and make it stack well. On the other hand, accurately adjusted machines or machines having fragile parts require a crate that has sufficient strength to resist weaving and skewing and protect the contents from the hazards of transportation.

The blocking and bracing of the machine in the crate is another important point to be considered in the packing of heavy machinery. Sufficient blocking should be used not only to prevent the machine from shifting, but also to support the weaker parts of the machine which are unable to carry the weight thrust on them when the crate is roughly handled.

Educational Work on Proper Crating

In addition to making tests in which special packing problems are studied, the information accumulated at the laboratory is disseminated in various ways, such as by correspondence, technical notes, articles, and conferences. Educational courses of instruction on container design are also given at the laboratory; these have proved to be a very successful means of disseminating information. These courses are designed to demonstrate, by actual tests, the fundamental principles underlying efficient container construction. Special courses are arranged to meet the needs of any particular group of manufacturers having similar packing problems. Each course lasts one week and is open to anyone paying the fee to cover the cost. More than 200 representatives from firms located in all parts of the United States and Canada have already taken advantage of this service.

Although a vast amount of scientific data has already been accumulated by the Forest Products Laboratory and other organizations, there are many factors influencing the economic construction of containers that have not been fully studied. Many years of intensive work will be needed to complete the study. Individuals or companies, by referring their wood problems to the laboratory, may obtain a statement of the tests thought necessary, and the laboratory will cooperate in their solution to the fullest extent possible with the available funds and personnel.

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IMPORTANCE OF GOOD LIGHTING IN FACTORIES

The question of the relation of illumination to industrial production has engaged the attention of illuminating engineers and industrial operators for some time. A number of investigations were conducted by the Division of Industrial Hygiene of the Public Service, but the investigations made have been limited in scope so that complete generalizations cannot be drawn from them. An investigation based on scientific research should solve the problem of the effect of illumination on rejections, strain on the operatives, and cost of production.

At a recent convention of the Illuminating Engineering Society, a committee of engineers and scientists, including members of the society who are authorities in the field of industrial lighting, met to discuss a program of scientific investigation to determine the relation of illumination to industrial production and the decrease of industrial fatigue in the various industries. An investigation conducted under the auspices of an impartial body, such as the above-named committee, will be of great value to the industries and their operatives and an economic service to the public. At the preliminary conference a tentative program was discussed which included the selection of industries in which it was desirable to carry out the investigation and in which the operators were dependent for guidance upon vision, for example, such industries as textile, boot and shoe, printing, clothing, metal- and wood-working industries. It was proposed to include in the research program practical tests under service conditions, to be carried out in the industries themselves. Headquarters of the research activities will be at the Massachusetts Institute of Technology, Cambridge, Mass.

Design of Machine Tool Feet and Bases

Typical Designs for Different Classes of Machines—Last of Three Articles

By FRED HORNER

THE preceding installments of this article have dealt with the different forms of feet and pedestals used to support the frames or bodies of boring machines, drilling machines, grinding machines, lathes, planers, automatic screw machines, and shapers. In the present installment various forms of machine feet used on milling machines and gear-cutters are described and illustrated. The type of bases used for portable machines and for very heavy-duty planers of the pit type are also described.

Base Design of Column-and-knee Milling Machines

The heavier knees, cross-slides, and tables used on the various types of milling machines built to take the heavier cuts demanded by present-day practice, have made it necessary to greatly strengthen the machine throughout. The strengthening and stiffening of the columns has generally been accomplished by the addition of ribs and by thickening the base castings. In the case of the Cincinnati miliers, the base is cast with a double section instead of with a single wall, which gives greater strength and rigidity.

A relatively thin tray, such as shown at *A*, Fig. 13, does not serve to strengthen the base materially, although it forms an excellent oil-catching medium. A deeper and stronger casting, such as shown at *B*, which is firmly bolted and doweled in place is usually preferable. The presence of a joint, however well united, is not tolerated by a good many firms who prefer to cast the base solid, as in the case of the design employed by the Brown & Sharpe Mfg. Co., which is shown in the view at *A*, Fig. 14. This base has the same characteristics as a separate base. Sometimes the use of vertical partition ribs helps to strengthen or stiffen the partitions that form the coolant or lubricant reservoir in the base.

Vertical-spindle Milling Machine Columns

The column of a vertical-spindle machine is similar to that of the plain or universal type when it has a sliding knee, and similar methods are applicable in designing the feet, which may be either solid or separate. When the table moves on a horizontal slide similar to that of a slotting machine, the horizontal portion is nearly always cast solid with the upright, as shown at *B*, Fig. 14, in order to obtain the greatest possible rigidity. Only when the dimensions of the machine render a single casting inexpedient, or the horizontal slide part is unusually long, is jointing resorted to, just as is the case with large slotting machines.

Since the development of the practice of station milling and continuous milling, the vertical-spindle designs have been subjected to certain modifications in the lower parts, with a view to increasing the capacity for the extra quantities of chips and the floods of coolant that have to be dealt with. An excellent exemplification of this may be observed in the Oesterlein Machine Co.'s "Ohio" tilted rotary machine. The table, being set at an angle, permits as much as 40 gallons per minute of coolant to flow over the work, which sweeps off the chips as soon as they are made, leaving the view clear and the clamps or fixture unencumbered. The chips fall into a strainer or grid, such as shown in the view at *B*, Fig. 15, and the coolant flows into a large reservoir in the foot. The sloping lip at the front permits a shovel to be used for removing the chips.

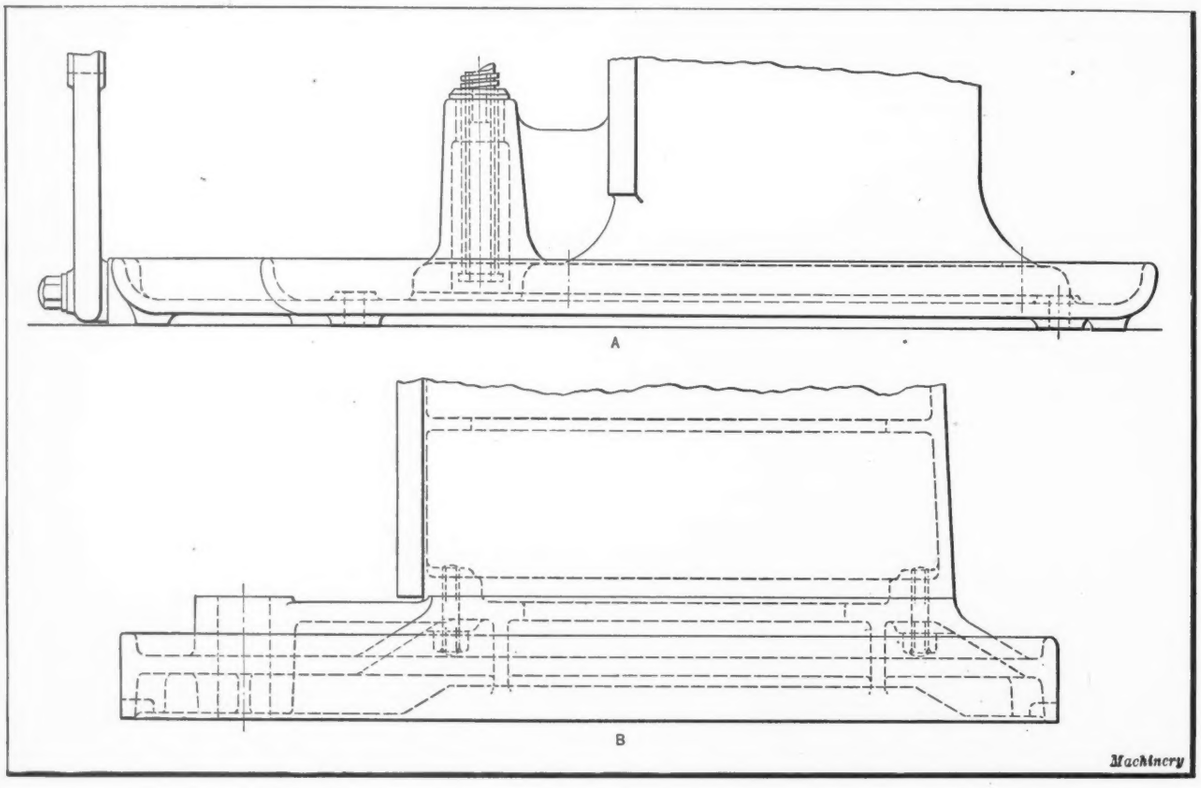


Fig. 13. (A) Milling Machine Base equipped with Shallow Tray; (B) Milling Machine Column with Bolted-on Feet

Foot for Gear-cutting Machine

In some makes of gear-cutters, the chips drop into a foot, and the coolant passes into a tank below. An example of this type is the base of the Brown & Sharpe gear-cutter shown at *A*, Fig. 15, which shows the oil-straining arrangements, and the cover, which may be taken off to permit the chips to be removed with a shovel.

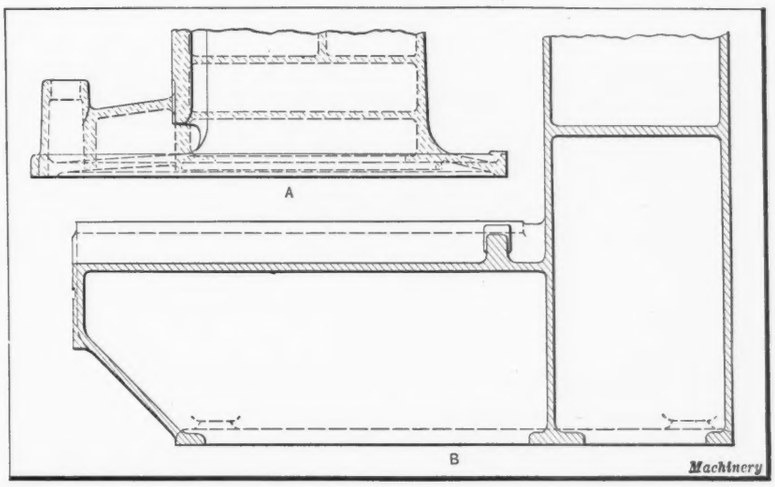


Fig. 14. Examples of Solid-cast Machine Feet

In certain forms of feet, the chips are allowed to fall directly on the floor, when dry cutting is done, and are simply swept away at intervals. Some of the drilling machine tables are designed according to this plan, and are made with side openings in the foot portion for the scraper or shovel. With this type of foot, as shown in Fig. 16, the chips drop down through the hole in the spindle to the floor.

Work-holding Feet

The various forms of feet that serve the important function of carrying work, either direct or through intermediary tables, will now be considered. The simplest example occurs on the smaller drilling machines which have the foot forked and prolonged forward with two or more T-slots. It will be noted that the foot shown at *A*, Fig. 17, has two T-slots in it. Numerous variations are met with in these and the larger machines, comprising plain bases and box bases. For instance, the base shown at *B* is cast with numerous ribs on the inside and T-slots on the edges as well as in the top. This type also has a box base as deep as it is wide. The elementary type of base shown at *B* should have a trough all around the edge if a coolant is required for the work. The high box-base becomes an essential when the size of the drilling machine is such that work would be too low on a floor type of foot. Stability is then insured by carrying the full sized base of the box to the floor, as shown at *C*. For the lighter weight radial machines and those of the sensitive type, such a full casting is not always necessary, and the box is often raised on feet at each end, which are of the familiar arch design.

Another type of machine that requires a work-holding foot, when used for heavy objects, is the cold saw. The slotted foot lies in front of or beside the saw, and may be a part of the whole base, or more often is a separate casting, tongued and bolted to the base. Rotary planers come in the same category, with still heavier and longer feet, as a good deal of the work is of larger bulk. In either of these machines, there may be a variation in the way in which a table is made to slide on the foot. This adjustment is sometimes made with a pinch-bar and rack.

In comparatively rare cases, the foot of a shaper will be T-slotted to receive massive castings which are beyond the scope of the table or the apron. There is, however, the difficulty of lateral adjustment, which involves the necessity for a traversing head, or a cross-slide fitted to the tool-box. An interesting development in this direction has been made by the Selson Engineering Co., Ltd., of London, England, in special 21-inch and 25-inch stroke heavy-duty shapers. The foot is T-slotted and the work may be bolted directly to it. However, a shallow table is usually laid on and guided by a tongue which fits into one of the T-slots and is clamped in place by bolts that fit tapped holes in strips passing through the outer T-slots. A lateral adjustment is made possible by means of a turret head which may be seen in the view at *D*, Fig. 17.

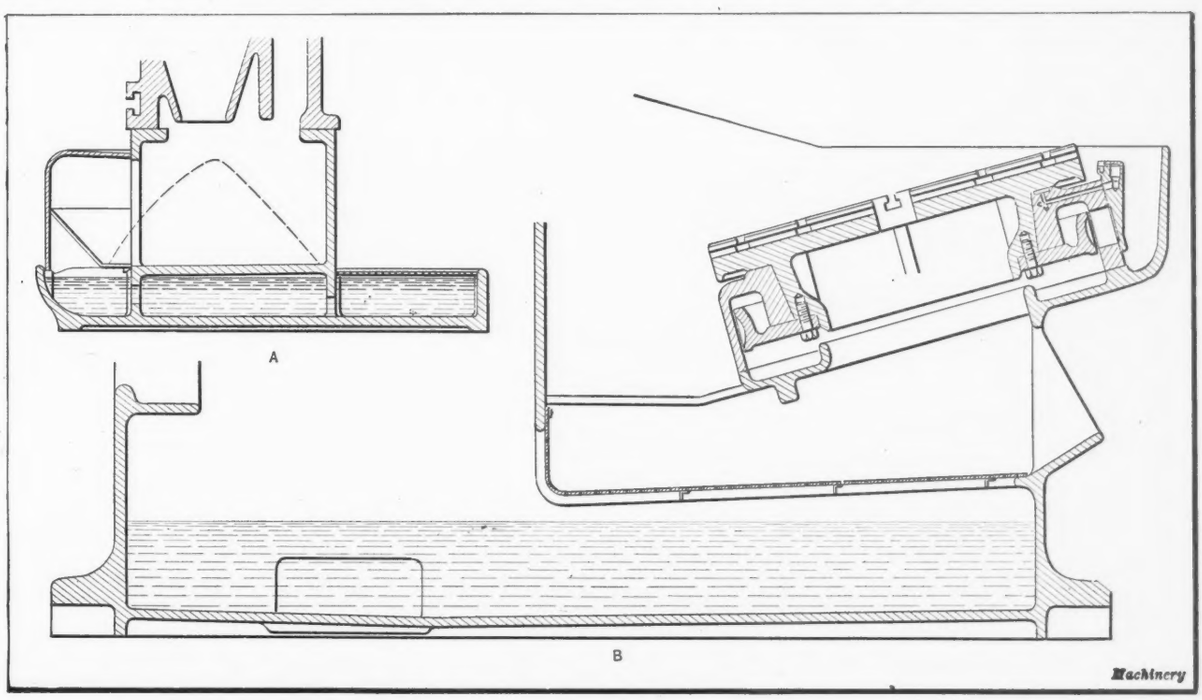


Fig. 15. (A) Type of Foot used on Brown & Sharpe Gear-cutters; (B) Foot of Ohio Tilted Rotary Milling Machine

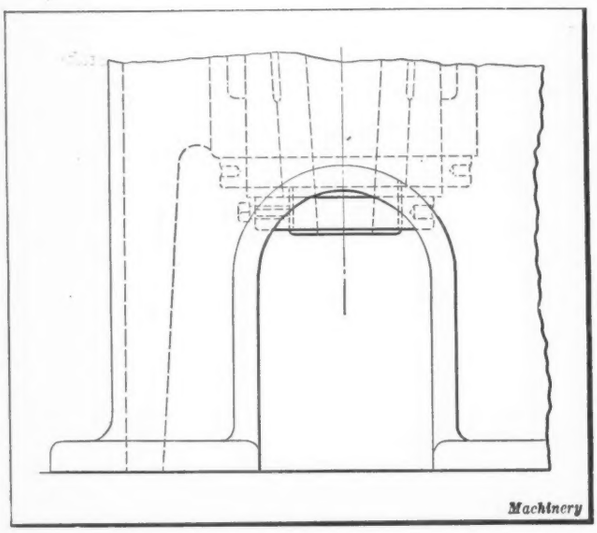


Fig. 16. Base provided with Opening for Removal of Chips

Work that must normally be put on the planer for a relatively minor operation, such as machining out the bearings or other surfaces, is easily dealt with on this shaper, the lateral adjustment from one spot to another being obtained by the movement of the table in the manner just described. The final settings of the tool and the cutting movement are produced by the short cross-slide, which is fitted to the end of the ram, carrying the tool-box. The machine has the usual table, but this is swung out of the way on a pivot when a bulky piece of work is being handled.

A large group of machines having work-holding feet is that comprised under horizontal boring, drilling, facing, and milling machines. The foot in this class of machines is not really subject to any limitation in length or breadth, but may be cast as a long and narrow base, or a long and wide base. The slide on which the spindle column moves can be either cast integral with the foot, or made separately. Generally, connection is made between the two, with bolts and tongue fittings, to preserve alignment. It is quite common practice to finish off one, two, or even three of the exposed edges or sides of the base with similar joint facings and tongues and bolt holes, so that extensions can be made should occasion demand, or a duplicate spindle head can be put on the other side or at one end. This practice is illustrated at *B*, Fig. 18, which shows two work-holding feet flanking the column slide-base with provisions for extensions. As a rule, the functions of these slotted tables are not confined solely to the reception of work; they often carry outboard supports, supplementary tables, and sometimes extra drilling or other machine heads for certain operations. Occasionally the slide base is placed at a lower level, in which case it is tongued underneath the work foot, as shown at *A*.

Portable Type Rotary Tables

Rotary tables are used on many kinds of machines. A complete machine is often mounted on a turntable foot, so that it can be swiveled or moved into position, thus eliminating the necessity of moving the work. A disk saw or a rotary disk can thus be presented at any desired angle to a long piece of work. This is often a far more convenient method than attempting to move the work, especially in a crowded shop. In connection with floor-plate operations, rotating feet or sub-bases are largely applied to the bases of portable drilling, boring, and milling machines. These members are fitted with worm-gearing to provide for circular positioning. A useful kind of adjustment is attainable if the swivel is mounted, not actually upon a circular foot, but in such a way that it can be made to slide along a short foot by operating a screw and ratchet handle. Places on the work are thereby reached without so much shifting of the foot.

Machine Feet Provided with Wheels

A rather exceptional type of machine foot is the castor type, which is sometimes put on the bottom of lathe standards to furnish a portable motor-driven outfit that can be used for turning jobs in places where it is easier and cheaper to bring the lathe to the work than to take the work to the lathe. Some grinders are also supplied with wheels which have some suitable provision for locking or putting the wheels out of action when the machine is in operation.

In drilling machines, two designs of portable bases are used. One is an oblong base having a wheel at each corner which enables the machine to be rolled about anywhere on the shop floor. Screw jacks are set down to raise the wheels slightly and cause the base to stand firmly in place. The jacks may be mounted on pivoted arms, as shown in the view at *A*, Fig. 19. By swinging out these arms a wider base is formed that resists overturning. Fixed bosses that stand out a little way from the base casting and are provided with screw jacks like the one shown at *D* in view *A* may also be used. Full adjustment of the spindle is obtained by the sliding of the column foot on the base, the rotative adjustment of the column, and the longitudinal and angular settings of the long slide that takes the drill-spindle.

Another design having feet provided with wheels assumes the form of a cross-girder with cradles at each end, not unlike a traveling crane. Two wheels on each end-cradle run on rails. The large plates to be drilled are located below and between the rails. Across the top of the girder is a slideable base that receives the column of a radial drilling

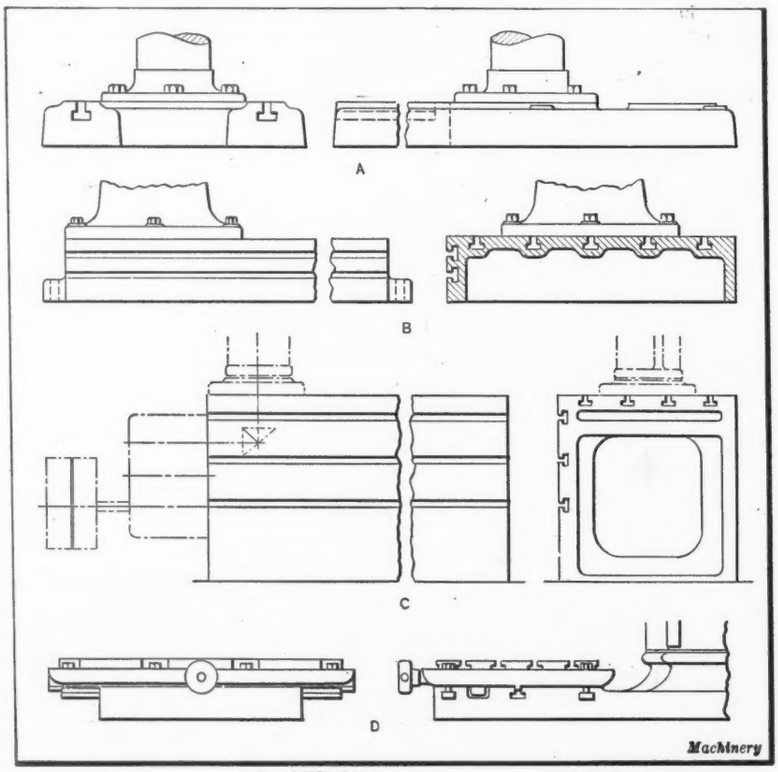


Fig. 17. (A) Example of Work-holding Foot; (B) Simple Type of T-slotted Foot; (C) Box Type of Foot; (D) Shaper Foot provided with Adjustable Table

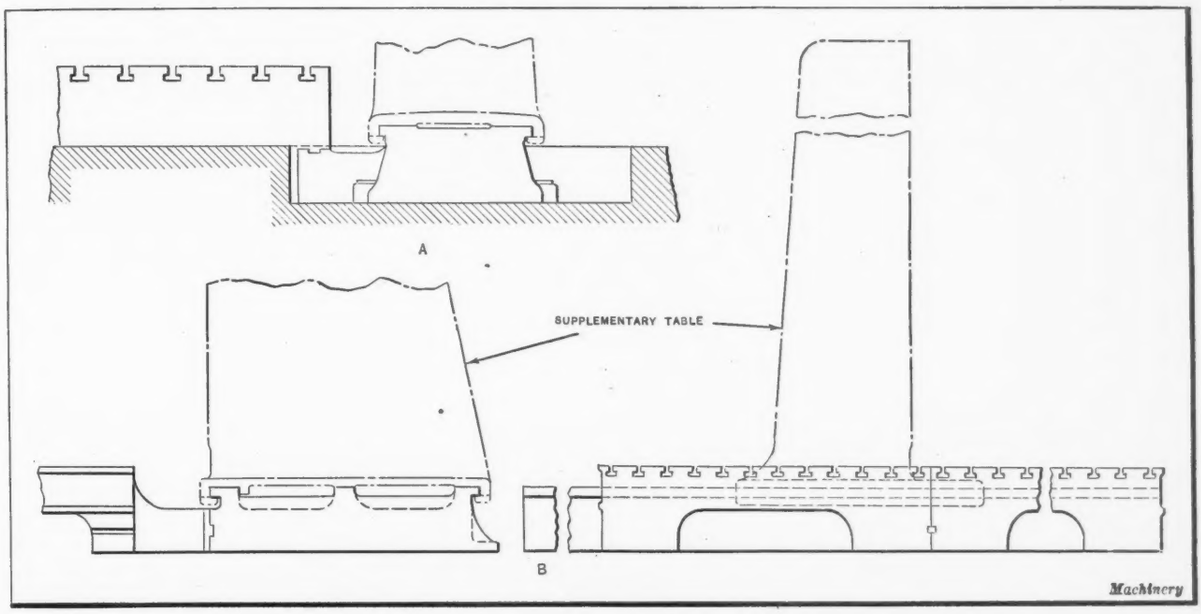


Fig. 18. (A) Method of joining Plate to Sunken Type of Slide Bed; (B) Holding Plate for Heavy Work

machine. By this construction the whole area within the radius of the spindle is covered.

In structural shops, the cast-iron work-supporting feet are often eliminated, and built-up brickwork bases, or timber supports are used in performing drilling operations on steel plates, girders, etc. The brickwork or timber may also serve to support small iron tables over which long pieces of work may be placed. Another variation is the laying down of brick, stone, or concrete piers, on top of which rails are placed to form a track for conveying fixtures from one machine to the next. Steel girders may be placed on the floor for the reception of structural work on the slightly exposed top surfaces with the alternative of using a strong-wheeled truck if necessary.

Deep or bulky articles are not always convenient to hold on the level of the shop floor, because abnormally high framings would be needed to hold the spindle or tool-slides over them, and the operator would therefore experience difficulty in operating the machine. By sinking a pit into the ground, and either covering the floor with girders or a plate to carry the work, or projecting a slide and table down into the pit, a large casting may be easily handled. A few drilling machines possess this feature, so also do some side planers, which may be set up in front of a pit of any required depth and width. With this type of machine, the floor of the pit serves as a foot, and also partly or wholly supports the work. The view at *B*, Fig. 19, shows a long bed located in an awkward position in the pit.

Massive pit planers of the type shown at *C* in reality possess two kinds of feet. The huge floor space is occupied with a T-slotted plate. There are also tall feet which sustain the slide-beds along which the columns of the cross-rail travel. Eight of these feet are provided on each side of the machine, which is capable of planing work up to 40 feet in length by 17 feet wide and 9 feet deep. This view also shows auxiliary detachable cross-girders for supporting pieces not deep enough to reach from the base to the tools, the girders being elevated simultaneously by a feed-screw in each foot, so that the brackets are moved up the face of each foot. Work *E* outlined on table *C* is a turbine case.

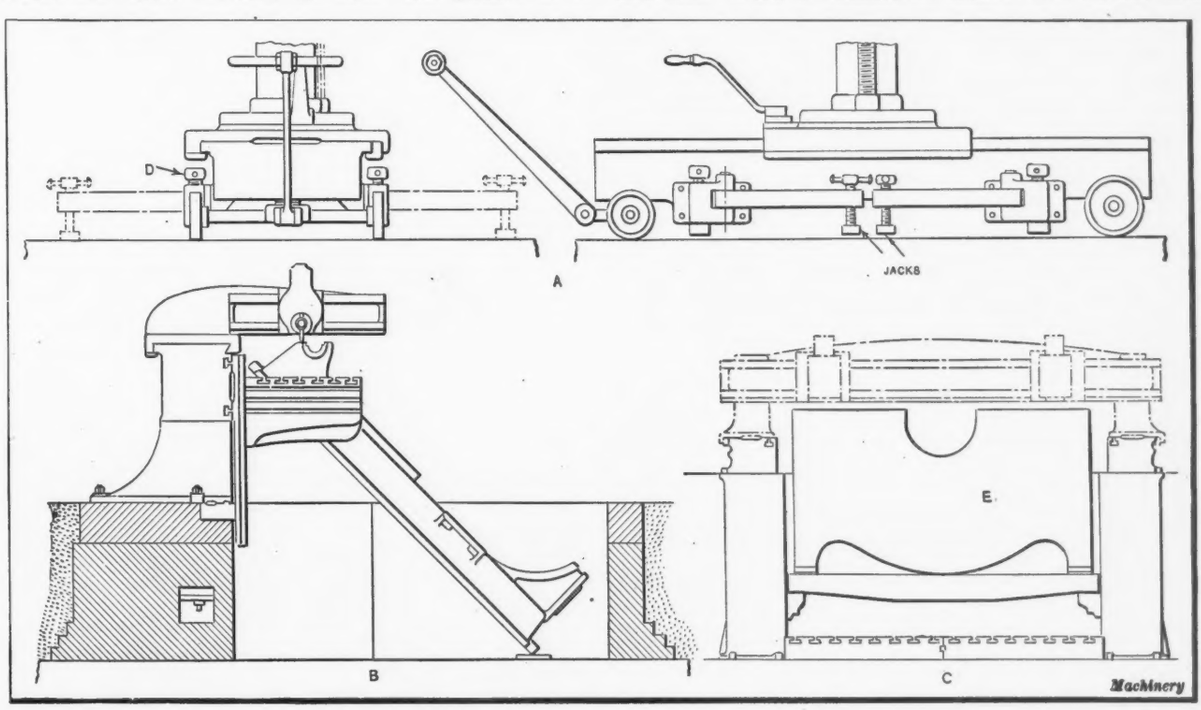


Fig. 19. (A) Machine Base provided with Wheels and Adjustable Jack Feet; (B) Side Planer with Pit Arrangement; (C) Pit Type of Planer

Notes and Comment on Engineering Topics

An addition of 5 per cent of nickel to 5 per cent chromium steel, says *Engineering*, produces a steel that is practically resistant to nitric acid. Briefly stated, the general effect of the addition of nickel to the chromium steel is to greatly increase the resistance to nitric acid, to materially increase the resistance to sulphuric acid, and to slightly increase the resistance to hydrochloric acid.

The project to tunnel the English Channel is continuously being kept alive by its promoters, although the British Government persists in refusing to grant the necessary authority. As far back as 1881 a trial heading extending about a mile under the sea was bored. After more than forty years, this bore has proved to be impervious to water and to maintain itself in good condition. It is estimated that it would take 4½ years to complete the tunnel under the Channel and that the cost would be nearly $150,000,000.

The appraisement of our resources, the systematization of our processes of production, fabrication, and distribution, the organization of our national housekeeping along safe, sane, universally just lines, unswayed by the influence of selfish interest upon the one hand, or impractical radicalism upon the other, is a task for the cool, impersonal, analytical method of the engineer. His task is becoming more and more definite and concrete; the necessity of unity of thought and the opportunity for unanimity of action are becoming more and more frequent.—*Fred R. Low, President American Society of Mechanical Engineers.*

In a review of industrial standardization during 1923, issued by the American Engineering Standards Committee, 29 W. 39th St., New York City, it is pointed out that there are now over 150 different standardization projects under way under the auspices of the committee. Some fifty standards have already received final approval, twenty-two of which were approved during 1923. Industrial standardization is a world-wide movement, and there are now national industrial standardization organizations in fifteen countries, besides the United States. These countries are Australia, Austria, Belgium, Canada, Czecho-Slovakia, France, Germany, Great Britain, Holland, Hungary, Italy, Japan, Norway, Sweden, and Switzerland. Of these, the work in Great Britain, Germany, and the United States is the most extensive.

Experiments have shown that the maximum strength of most steels is reached at a temperature of from 500 to 550 degrees F. It is of interest to note that the strength of steel does not increase uniformly from ordinary room temperature until it reaches its maximum at the temperature mentioned. On the other hand, the strength of steel decreases until the temperature reached is about 220 degrees, and from that point on there is an increase until the maximum strength is reached. When a temperature of 550 degrees F. has been exceeded, there is a steady reduction in strength as the temperature rises, until a cherry red heat, at about 1600 degrees F., is reached, when there is practically no tensile strength left in the steel. Cutting tools for machining steel hold their edges better when heated to a temperature somewhat above the atmosphere, than when used at atmospheric temperature. Usually, the pressure and friction of the cut produces this temperature.

The world's largest hydro-electric power unit was recently placed in operation at Niagara Falls. This generating unit is of 65,000 KVA, driven by a 70,000-horsepower hydraulic turbine at a speed of 107 revolutions per minute, and generating current of 12,000 volts at 25 cycles. The total weight of the installation is over 1750 tons. This is the first of three such units now being installed at Niagara Falls, two by the General Electric Co. in conjunction with the William Cramp & Sons, Ship & Engine Building Co., and the third by the Allis-Chalmers Co. The station, when completed, will have a rated capacity of 454,000 horsepower. The unit just installed uses 3500 cubic feet of water per second, with an estimated efficiency of at least 93 per cent. Using the same amount of water as was formerly required by seven 5000-horsepower units, it delivers electric energy equivalent to the output of fourteen such units. This explains clearly why there is a tendency toward large units in hydro-electric installations.

How old are locomotives when they are scrapped? A study has recently been made of the length of life of locomotives on American railroads, from which it was found that the average age of locomotives dismantled or recommended for dismantling on the Pennsylvania Railroad is 29.4 years, and on the Chicago, Milwaukee & St. Paul, 35.5 years, while most of the other railroads vary between these figures. In general, the average retiring age of locomotives is approximately from 30 to 33 years. On the Louisville & Nashville Railroad nearly 25 per cent of the engines have given 30 years' service or over. Eighty-eight out of 1306 locomotives on this road have been in service over 40 years, and 20 have been in service over 50 years, the oldest engine still in service having been built in 1870. It is interesting to note in this connection how the average weight of locomotives has increased in the last fifty years. In 1870, passenger engines averaged about 66,000 pounds, while in 1920 we had passenger engines weighing 280,000 pounds. The freight engines of 1870 averaged 90,000 pounds, while heavy-type engines in 1920 averaged 320,000 pounds.

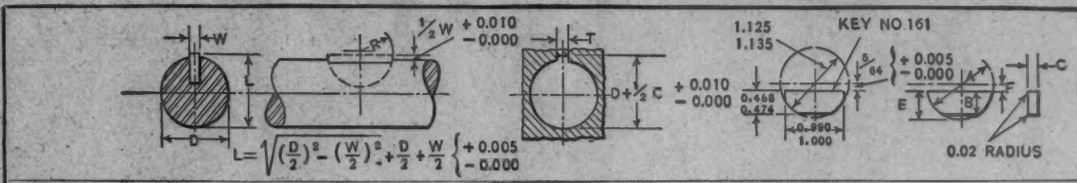
Inventive genius is daily solving problems that only a few years ago were pronounced unsolvable. One of the leading exponents in radio telegraphy and telephony recently stated that he no longer says about anything that it cannot be done. "We have so many things," said he, "that twenty-five years ago were considered impossible, that the engineer and scientist of today are very careful in expressing their opinions in regard to the impracticability of new inventions." When John Ericsson invented the screw propeller, he tried to have it adopted by the British navy, but the British naval officer who passed upon new inventions and developments, and who was undoubtedly a mechanical expert in shipbuilding and ship-propulsion in his day, turned down Ericsson's invention and pronounced it inoperative and useless. Yet, present-day merchant vessels and navies would be inconceivable without screw propellers, and any other means for driving an ocean-going vessel is unthinkable at the present time. The telephone was received with much the same skepticism, one of the greatest electrical experts of that day advising inventors to steer clear of Alexander Graham Bell's fanciful dream. Learned professors in mathematics and physics scientifically proved that a heavier-than-air flying machine was an impossibility. It is risky in these days to say that there is anything in the field of engineering that cannot be done.

CUT OUT ON THIS LINE

PUNCH ○ Punch-holes are spaced to fit standard loose-leaf ring binders for sale by stationers generally. ○ PUNCH

CUT OUT ON THIS LINE

WHITNEY KEYS AND KEYWAYS (WOODRUFF SYSTEM)—1



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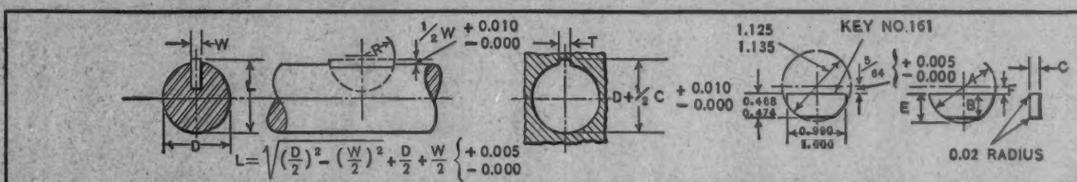
	Min.	Max.	Min.	Max.	Min.	Max.		Min.	Max.	Min.	Max.	Min.	Max.
0	0.250	0.260	0.112	0.117	0.0625	0.0635	0.008	0.112	0.117	0.0615	0.0625	0.0635	0.0645
00	0.3125	0.3225	0.135	0.140	0.0937	0.0947	1/64	0.135	0.140	0.0927	0.0937	0.0947	0.0957
000	0.375	0.385	0.167	0.172	0.125	0.126	1/64	0.167	0.172	0.124	0.125	0.126	0.127
1	0.500	0.510	0.1875	0.1935	0.0625	0.0635	3/64	0.198	0.203	0.0615	0.0625	0.0635	0.0645
2	0.500	0.510	0.1875	0.1935	0.0937	0.0947	3/64	0.198	0 203	0.0927	0.0937	0.0947	0.0957
3	0.500	0.510	0.1875	0.1935	0.125	0.126	3/64	0.198	0.203	0.124	0.125	0.126	0.127
4	0.625	0.635	0.234	0.240	0.0937	0.0947	1/16	0.245	0.250	0.0927	0.0937	0.0947	0.0957
5	0.625	0.635	0.234	0.240	0.125	0.126	1/16	0.245	0.250	0.124	0.125	0.126	0.127
6	0.625	0.635	0.234	0.240	0.1562	0.1572	1/16	0.245	0.250	0.1552	0.1562	0.1572	0.1582
61	0.625	0.635	0.234	0.240	0.1875	0.1885	1/16	0.245	0.250	0.1865	0.1875	0.1885	0.1895
7	0.750	0.760	0.296	0.302	0.125	0.126	1/16	0.308	0.313	0.124	0.125	0.126	0.127
8	0.750	0.760	0.296	0.302	0.1562	0.1572	1/16	0.308	0.313	0.1552	0.1562	0.1572	0.1582
9	0.750	0.760	0.296	0.302	0.1875	0.1885	1/16	0.308	0.313	0.1865	0.1875	0.1885	0.1895
91	0.750	0.760	0.296	0.302	0.250	0.251	1/16	0.308	0.313	0.249	0.250	0.251	0.252
10	0.875	0.885	0.359	0.365	0.1562	0.1572	1/16	0.370	0.375	0.1552	0.1562	0.1572	0.1582
11	0.875	0.885	0.359	0.365	0.1875	0.1885	1/16	0.370	0.375	0.1865	0.1875	0.1885	0.1895
12	0.875	0.885	0.359	0.365	0.2187	0.2197	1/16	0.370	0.375	0.2177	0.2187	0.2197	0.2207
A	0.875	0.885	0.359	0.365	0.250	0.251	1/16	0.370	0.375	0.249	0.250	0.251	0.252
121	0.875	0.885	0.292	0.295	0.250	0.251	1/16	0.370	0.375	0.249	0.250	0.251	0.252
13	1.000	1.010	0.421	0.427	0.1875	0.1885	1/16	0.433	0.438	0.1865	0.1875	0.1885	0.1895
14	1.000	1.010	0.421	0.427	0.2187	0.2197	1/16	0.433	0.438	0.2177	0.2187	0.2197	0.2207

*All dimensions expressed by fractions are held within limits of + 0.005 inch and — 0.000 inch.

MACHINERY'S Data Sheet No. 29, New Series, March 1924

CUT HERE

WHITNEY KEYS AND KEYWAYS (WOODRUFF SYSTEM)—2



Key Number	Diameter of Key A		Height of Key B		Thickness of Key C		Key Cut Below Center* F	E		Width of Keyseat W		Width of Keyway T	
	Min.	Max.	Min.	Max.	Min.	Max.		Min.	Max.	Min.	Max.	Min.	Max.
15	1.000	1.010	0.421	0.427	0.250	0.251	1/16	0.433	0.438	0.249	0.250	0.251	0.252
B	1.000	1.010	0.421	0.427	0.3125	0.3135	1/16	0.433	0.438	0.3115	0.3125	0.3135	0.3145
152	1.000	1.010	0.421	0.427	0.375	0.376	1/16	0.433	0.438	0.374	0.375	0.376	0.377
141	1.000	1.010	0.359	0.365	0.250	0.251	1/8	0.370	0.375	0.249	0.250	0.251	0.252
131	1.000	1.010	0.344	0.350	0.3125	0.3135	1/16	0.433	0.438	0.3115	0.3125	0.3135	0.3145
16	1.125	1.135	0.468	0.474	0.1875	0.1885	5/64	0.480	0.485	0.1865	0.1875	0.1885	0.1895
17	1.125	1.135	0.468	0.474	0.2187	0.2197	5/64	0.480	0.485	0.2177	0.2187	0.2197	0.2207
18	1.125	1.135	0.468	0.474	0.250	0.251	5/64	0.480	0.485	0.249	0.250	0.251	0.252
C	1.125	1.135	0.468	0.474	0.3125	0.3135	5/64	0.480	0.485	0.3115	0.3125	0.3135	0.3145
161	1.125	1.135	0.468	0.474	0.3125	0.3135	5/64	0.480	0.485	0.3115	0.3125	0.3135	0.3145
19	1.250	1.260	0.531	0.537	0.1875	0.1885	5/64	0.542	0.547	0.1865	0.1875	0.1885	0.1895
20	1.250	1.260	0.531	0.537	0.2187	0.2197	5/64	0.542	0.547	0.2177	0.2187	0.2197	0.2207
21	1.250	1.260	0.531	0.537	0.250	0.251	5/64	0.542	0.547	0.249	0.250	0.251	0.252
D	1.250	1.260	0.531	0.537	0.3125	0.3135	5/64	0.542	0.547	0.3115	0.3125	0.3135	0.3145
E	1.250	1.260	0.531	0.537	0.375	0.376	5/64	0.542	0.547	0.374	0.375	0.376	0.377
22	1.375	1.385	0.578	0.584	0.250	0.251	3/32	0.589	0.594	0.249	0.250	0.251	0.252
23	1.375	1.385	0.578	0.584	0.3125	0.3135	3/32	0.589	0.594	0.3115	0.3125	0.3135	0.3145
F	1.375	1.385	0.578	0.584	0.375	0.376	3/32	0.589	0.594	0.374	0.375	0.376	0.377
24	1.500	1.510	0.625	0.631	0.250	0.251	7/64	0.635	0.640	0.249	0.250	0.251	0.252
25	1.500	1.510	0.625	0.631	0.3125	0.3135	7/64	0.635	0.640	0.3115	0.3125	0.3135	0.3145
G	1.500	1.510	0.625	0.631	0.375	0.376	7/64	0.635	0.640	0.374	0.375	0.376	0.377

*All dimensions expressed by fractions are held within limits of + 0.005 inch and — 0.000 inch.

MACHINERY'S Data Sheet No. 30, New Series, March 1924

BEARING METAL RESEARCH

There are few technical or engineering subjects on which there is a greater dearth of information than bearing alloys. In considering the annual expenditures for these metals, it is surprising that no nationally organized research, up to the present time, has ever been planned or suggested. In 1916, the American Society of Mechanical Engineers appointed a committee on bearing metal research; this committee has worked as time and opportunity permitted, and the results have been set forth in several progress reports. The real accomplishments of this committee have resulted in crystallizing definite ideas in relation to the manner in which research should be undertaken on a large scale.

Up to the present time practically all of the bearing materials that have been studied and tested in the various industrial and college laboratories have been made by mechanical engineers who have given but scant consideration to the chemical composition of the material. The metallurgy and metallography of these alloys have received little or no attention. Another still more striking shortcoming in this study is that the bearing only has been considered; the journal has been neglected. The inadequacy of past research in this field is brought out strikingly when we consider that, for satisfactory service conditions, the journal and bearing must polish each other; therefore there must be some definite relation between the hardest microscopic crystals in the bearing and those of the journal. This fact had never been taken into consideration until the committee of the American Society of Mechanical Engineers undertook this work. This committee has developed an instrument by means of which the abrasive hardness of the different microscopic components of the various alloys can be determined in a practical way. The study of micro-hardness of different alloys in this research is important. The American Society for Testing Materials has now instituted a committee on micro-hardness which is actively taking up the subject.

The scope of this research is so far-reaching that there is no industry in the country that would not be benefited by it; and the actual work to be done is so great that it should not be left for the spare time of private individuals. The work of the American Society of Mechanical Engineers' special research committee on bearing metals was begun by three busy men who have carried it to a point where for best results it is now necessary that their time and work be supplemented by efforts on a much larger scale. They have no intention of in any way relinquishing their interest in the work—quite the contrary; but for more far-reaching results, it is now proposed to raise a fund of $50,000 for the purpose of energetically prosecuting research in this field by employing a well qualified specialist for a period of probably five years, who can devote his entire time to this work. His work would be done at the Bureau of Standards in Washington, where he would have every facility and advantage which the diversified equipment in this institution affords. The bureau, through its director, has expressed its willingness to cooperate. The period of five years of necessity is more or less tentative; nevertheless, it is necessary, in order to secure the services of a highly trained investigator for this work, that he be given assurance of employment for a definite period, and that the project have substantial financial backing. For the large amount of work necessary in order to cover the entire field systematically, five years seems but a brief period.

In this work it will not only be necessary to study the different steels that are now being used in journals, covering the entire range from the low-carbon to the special alloy steels, but also all the alloys now used as bearing metals. It is the intention first to classify these alloys and their constituents as to micro-hardness. This work, it is estimated, will require the first two years of the investigation. It is planned that while this information is being obtained, a large number of journals and their bearings which have given phenomenal or unusually long service be secured; these will then be studied by the aid of all the accumulated information available.

It is proposed to supplement the present committee of the American Society of Mechanical Engineers with an advisory committee made up of specialists from various national technical societies, to be appointed by the Engineering Foundation, 29 W. 39th St., New York City. The latter organization has offered to act as financial trustee for this undertaking, to receive all contributions, and to supervise the entire expenditures. The interest of the Engineering Foundation is further evidenced by the fact that it has contributed $5000 for this undertaking, and a number of interested manufacturing concerns have already, without solicitation, expressed their desire to contribute to this fund. The research is one in which all users of bearings and manufacturers of bearing materials are vitally interested, and in view of the far-reaching results to be obtained, the successful financing of the project is confidently anticipated.

The members of the special research committee on bearing metals of the American Society of Mechanical Engineers consists of C. H. Bierbaum, consulting engineer, Lumen Bearing Co., Buffalo, N. Y., chairman; John A. Capp, chief of testing laboratory of the General Electric Co., Schenectady, N. Y.; and Professor H. Diederichs, director of mechanical engineering, Cornell University, Ithaca, N. Y.

* * *

POST OFFICE ASKS FOR BETTER ADDRESSING

The postmaster-general has published a statement to the effect that approximately $1,740,000 a year is spent in the various post offices throughout the country in looking up and providing street addresses on mail matter that is incompletely addressed by the sender. The greatest offenders in regard to incompletely addressed mail are stated to be large business houses.

It is estimated that 200,000,000 pieces of mail are yearly turned over to the "directory service" of the post offices, which means that post office employes must take time from the regular handling and distributing of mail in an endeavor to provide correct addresses for this huge volume of incompletely addressed mail. In New York City alone the cost of this directory service department is about $500 a day. Mail inadequately addressed and requiring directory service is by necessity delayed, and often it must be returned to the sender for a new address.

One of the main causes of incomplete addressing is that so many firms and business houses consider it unnecessary to give the street address on their stationery, believing that they are of such importance that every postal employe in their city or town knows of them and where they are located. Accordingly, their street address is not given on order blanks, letter-heads, envelopes, or in their advertising. Recently a list was prepared of firms whose mail was delayed because of the need for directory service, and it was found that among these there were 281 business houses who were using stationery upon which no address was to be found other than the city in which they were located, and in some cases even this was missing.

The post office department can give better service to the business concerns of the country if two rules are followed: (1) On all letter-heads, envelopes, and order blanks, and in all advertising, be sure to give full and complete street address; (2) on all mail going out from the office, be sure that complete street addresses are given when it is at all possible to do so.

* * *

Shipments of American iron and steel products to Japan in November and December, 1923, were the largest for many months, due to the urgent need for materials for the construction of temporary buildings at Tokio and Yokohama, according to a recent Commerce Report.

EDITORIAL COMMENT

on Mechanical Subjects of Current Interest

ACTION ON GEAR TESTING

Although few machine details are more generally used than gears, definite information on the strength of gear teeth is difficult to obtain. This condition is due to the great number of factors that affect the strength of gear teeth, among which are the material from which the gears are made, the speed at which they are running, the pitch, the width of the face, the accuracy with which the teeth are cut, the method of lubrication, and the character of the load, whether steady or intermittent.

By the concerted efforts of the American Society of Mechanical Engineers, the National Machine Tool Builders' Association, and the American Gear Manufacturers' Association, thorough experiments will soon be undertaken to determine definitely the important factors that affect the strength of gear teeth. It is expected that these experiments will result in obtaining the data for accurate formulas for calculating the strength of different types of gearing, working under different conditions.

Very little is known about the causes of noise in gear drives, and that subject should be investigated also; for until the causes are determined, the noise cannot be eliminated. Running tests will prove most important, for determining both the strength of gear teeth and the causes of noise; but the importance of static tests must not be overlooked, because it is only by making such tests that the qualities of the materials used for gearing can be standardized and accurate specifications prepared covering the tensile strength, elastic limit, elongation and hardness. Without such specifications it would not be possible to select materials for the future duplication of the test results.

These experiments will probably extend over a period of years, and it is better that they should be conducted slowly and with great care and accuracy, and that the results should not be published prematurely. Fortunately, this investigation has been delegated to men who will see that it is searching and complete.

* * *

THE NEED FOR TRAINED EXECUTIVES

The National Industrial Conference Board has recently published a report dealing with the relation of engineering education to American industry which answers the inquiry, "Do the industries in the United States need more engineers than are now graduated from engineering schools and colleges?" This report states that the number of men engaged as administrators, supervisors and technical experts in the manufacturing and mechanical industries, the extraction of minerals, and in transportation, according to the 1920 census figures, was approximately 750,000. Based on the increase in such occupations since 1900, it is estimated that about 200,000 more men will be needed in positions of responsibility in 1930 than in 1920, and this is in addition to the number necessary to replace those who pass out of the industrial field during the ten-year period. While this estimate includes some men in leading positions to whom an engineering training may not be essential, it is becoming generally recognized that a technical training of some kind is not only valuable, but often necessary, to any man holding a position of responsibility in an industry that depends mainly upon engineering processes for its results.

At the present time the engineering schools of the United States are graduating about 9000 young men annually. On the basis of the estimate made by the National Industrial Conference Board, a minimum of 20,000 annually is actually needed by our industries and transportation systems. This means that many positions must be filled by men of comparatively limited training, or by men who are self-taught. The figures also indicate that great possibilities for advancement are open to men who acquire knowledge on technical subjects through individual study outside of the engineering schools and colleges. There are many opportunities ahead in the engineering and other industrial fields for those who have the ambition to grasp them.

* * *

INACCURACY IS COSTLY

In this hustling age there is a strong temptation to consider quantity before quality, to overlook the importance of accuracy and to pay less attention to detail. This is especially true on the part of young and ambitious men with latent executive ability. They sometimes think that detail work is beneath their dignity, and that they should be concerned only with what they consider important work.

This tendency to overlook details and to neglect accuracy both in descriptive statements and mechanical calculations is very evident in many of the manuscripts received by a mechanical journal. Frequently it is necessary to send several letters to the writer of an article before the statements therein have been made clear. The calculations of such a writer always must be checked, and frequently changed or sent back to him to be corrected.

Men in the mechanical field, and young men especially, should be made to realize that inaccuracy is extremely costly in engineering work. It is not enough to apply the correct principles and the proper formulas to the solution of a problem. The formulas must be accurately worked out, and the plain arithmetical work must be done just as carefully as the mathematical work required in the deduction of the formulas and the solving of the equations. It is better to work slowly and accurately than to work so fast that it is necessary to frequently retrace one's steps in order to find mistakes. The man who trains himself to accuracy in details will soon find that he can be accurate and also work rapidly. But the man who begins by trying to acquire speed at the expense of accuracy in detail work, never will be able to achieve real efficiency in his work.

* * *

BUILDING UP GOOD-WILL

In a middle-western city there is a concern that builds special machinery and equipment, employing about one hundred men, which has inspired confidence among its customers by the adoption of a unique policy.

In making estimates and bidding on contract work, this concern bases its price on a fair profit plus a moderate allowance for unforeseen contingencies, which frequently occur on such work. This policy is usual enough; but the unusual part is that when the work is completed, if the concern finds that the total profit is greater than was included in the estimate, it refunds the excess to the customer. Recently it has been a common occurrence to return about 6 per cent of the estimated price.

Naturally, customers who have had this experience tell their friends, and often orders are booked without any cost estimate being requested. This unique method of building up good-will has been very successful.

The Business Outlook in the Machinery Field

Summary of the Opinions of Over One Hundred Business Leaders

IT is not easy to forecast business conditions and even those who have made it their profession to weigh past and present conditions in the balance and thereby foretell the future, have often made wrong guesses. Nevertheless, no business can be successfully managed without a plan, and a plan presupposes an estimate of future conditions.

With a view to ascertaining the consensus of opinion in regard to the future of business during the remainder of this year, MACHINERY has asked more than one hundred of the foremost leaders in the industrial field for their opinions, based upon their own plans for the year. This inquiry covered not only the machine tool and shop equipment industry, but was extended to embrace automobiles and automobile accessories, steam engines, gas engines, pumps and pumping machinery, steam turbines, electrical machinery, power transmission equipment, elevating and conveying machinery, road and excavating machinery, mining machinery, textile machinery, woodworking machinery, printing plant equipment, sewing machines, typewriters, cash registers, adding machines, ball bearings, and kindred industries. The results of this inquiry are briefly set forth in the following paragraphs.

The Automobile Industry Expects no Appreciable Change

In the automobile industry the consensus of opinion is that the production in 1924 will be approximately the same as in 1923. A few firms contemplate an increased volume of business; one only expects to reduce production. With two exceptions, there are no extensive increases in plants contemplated, but a considerable amount of replacement of old equipment by new is under way.

In the automobile accessories field, practically the same opinions prevail. A very active business is looked forward to during the first six months of the year, with a somewhat decreased volume during the latter six months. This is merely repeating the annual experience in the automobile industry.

Steam Engine Production may be Slightly Reduced

In the steam engine field, business is not quite so active at present as it was this time last year. Nevertheless, there is sufficient prospective business so that sales may equal those of the past year, or, at worst, only be 10 or 15 per cent less. There are no plans for the extension of plants.

In the steam turbine and larger power plant machinery field the reports are more optimistic. Plants engaged in this line were fully occupied in 1923, and are anticipating approximately the same volume of sales during the present year. One concern anticipates a slight reduction, possibly about 10 per cent, with the expectation that a somewhat larger sales expense may be necessary to obtain this volume of business. In this field there will be comparatively small increases in plant capacity, not more than 5 per cent. The summary of opinions covering power plant equipment refers to the electrical industry in general.

The locomotive building industry will doubtless see a falling off in business during 1924. The volume of business during the past year was unusually large, over 4000 locomotives having been completed. It is expected that the volume of business this year will be from one-half to two-thirds of that of the past year. Some of the equipment of the locomotive shops, however, is likely to be replaced even in view of the reduced business. The demand for industrial locomotives is continuing at the 1923 rate.

In the gas engine field one concern finds the demand for small gas engines comparatively light, while the larger sizes are selling well. Another expects an increase of 25 per cent over 1923; while still another looks for a 20 per cent decrease.

In the pump and pumping machinery business approximately the same sales as in 1923 are anticipated. A normal amount of purchasing of new equipment will take place mainly to replace old machinery.

One of the leading concerns in the valve and fittings business looks forward to the same volume of business in 1924 as during the past year. Similar reports come from a number of industries in miscellaneous lines, indicating, on the whole, that no great change is expected during the present year in the industrial conditions.

Increases Expected in Power Transmission and Contractors' Machinery

One of the leaders in the power transmission field expects an increase of over 60 per cent in the business of the present year, and is also planning to increase the plant capacity by 25 per cent. New equipment will be added and old equipment will be replaced by more efficient tools. Another leader in the transmission and conveying equipment field expects a reduction of from 10 to 15 per cent in this year's business. This firm has, nevertheless, made up an equipment budget calling for quite a liberal expenditure for new equipment to replace old and obsolete tools, saying: "All expenditures for equipment depend largely on the general business conditions, although we do not hesitate to purchase a new or modern tool to replace one or two old ones which we may have, whether business is good or not."

Another manufacturer in the same field advises that the orders on his book at present are 50 per cent higher than they were at this time last year, and although he would not look forward to sales in excess of those of 1923, present indications are that business may be from 10 to 15 per cent greater. This increase of business activity can be taken care of without any increase in plant equipment.

Two of the leaders in excavating and road-building machinery are looking forward to an increase of business over the previous year of from 10 to 20 per cent. One of these companies has increased its manufacturing capacity about 20 per cent during the last six months and expects to do at least this volume of increased business. This concern will also be in the market for additional equipment during the coming year. Another concern in this field is also expecting to increase its plant capacity slightly, mostly through replacements.

A well-known mining machinery builder looks forward to 50 per cent better business during the present year, but expects that it will be fully as expensive to obtain this business as in 1923, if not more so.

Woodworking Machinery Builders are Optimistic

Reports from the woodworking machinery field are optimistic. The expectations are that 1924 will not only duplicate but in some cases exceed the 1923 business. In some instances, the year has started somewhat lighter than last year, and it is expected that sales expenses may run somewhat higher. Needs for increased plant capacity will generally be taken care of by increasing the efficiency and tooling equipment within the plants, rather than by installing new equipment; but one of the leading makers of woodworking machinery is increasing his plant capacity.

The Textile Industry Expects Fair Business but no Boom

Business in the textile field has fallen off somewhat, as compared with this time last year, and it is not expected that it will run over 80 per cent of the 1923 business. There will be comparatively few increases in plant capacity during the coming year, because several of the large companies are following conservative policies in view of the decreased volume of business. One of the leaders in this field writes as follows: "Altogether we are, I think, going to have fair business this year. It will be conducted on a very conservative line. No one will be anticipating any booms, and therefore there will not be any. Very few will be anticipating any depressions, and for the same reason, in my judgment, there will be no depressions."

Sewing Machine, Typewriter, Adding Machine, and Cash Register Plants will be Well Employed

In the sewing machine field increases in sales of from 10 to 15 per cent are anticipated. Present plants are amply large enough to take care of a moderately increased production. The equipment in several of the sewing machine plants is modern and up-to-date and will not require replacement, although in plants of the size engaged in sewing machine manufacture there will, of course, always be some new equipment added to meet the need for improved manufacturing methods. An increase of approximately 10 per cent is looked forward to in the typewriter business. This also can be taken care of by present plant capacities. One of the well-known concerns in the adding machine business expects considerably increased sales. Additional machinery will be purchased, some of which has already been ordered. The cash register business is looking forward to an increase of 25 per cent over the 1923 volume, which must be taken care of by additional plant equipment.

Printing Plant Machinery Builders Expect Good Business

One of the builders of printing presses expects an increase in business of 25 per cent during the present year. In this case, new equipment will be added and old machines replaced in order to meet the increased volume of business. The first month of the year showed good indications of realizing the expected increase. Another printing press manufacturer expects his volume of business to remain approximately the same as in 1923, but to obtain this business a slightly increased sales expense will be necessary. This company has considerable faith in the future, and is at present constructing a large plant that will increase its capacity in the printing press field by 50 per cent.

Ball Bearing Plants Generally Expect Increased Volume of Business

In the ball bearing field the estimates for next year's business vary. Among the better known firms, one expects to have approximately the same volume of business as during the past year, another anticipates an increase of 25 per cent, and still another an increase of 50 per cent. In the latter case, a 25 per cent increase in plant capacity is planned, which will be taken care of by replacing old equipment and adding new machinery.

In the industrial gear manufacturing field a fair year is anticipated, but the best business is expected after April 1. In this field it is difficult to estimate exactly what volume of business may be looked forward to, for the opinions vary from a volume equal to 1923 to a business 50 per cent in excess of last year's sales. The gear business depends, of course, very closely upon activity in other fields.

The Outlook in the Machine Tool Industry

The consensus of opinion among many of the leading men in the machine tool industry is that the volume of business in 1924 will be equal to, or slightly better than, that of 1923, but in order to reach this goal it may be necessary to plan for a greater sales expense than was required during the past year. The larger share of the machine tool business during this year will doubtless come from the automotive industries, although it is expected that, proportionately, the demand of these industries will be smaller than last year, while other fields will absorb a larger number of machines. The electrical field is also looked upon as an important purchaser of equipment. The estimates of the productive capacity of the machine tool industry that will be required in various plants during the year, vary in the case of the majority of the plants all the way from 50 to 75 per cent of full capacity, with occasional instances where from 80 to 100 per cent will be required.

In the heavier types of machine tools, and generally in the standard lines, the railroads are expected to be important purchasers, and a more generally distributed business than that of 1923 is looked forward to by many manufacturers. In addition to the industrial fields already mentioned, manufacturers of contractors' machinery, woodworking machinery, and all industries related to the building trades, are looked to as offering fair possibilities for business.

One well-known manufacturer writes: "It is our opinion that the machine tool business is gradually growing better, and it will continue to advance during the next two or three years, the increase, however, being very gradual."

In the small tool field the estimates of the present year's business, as compared with last year's, vary from 90 to 115 per cent, and in at least one instance an increase of plant capacity of from 10 to 25 per cent is contemplated, to be taken care of by replacing obsolete equipment with new machinery giving greater production.

In the special machinery, die, jig, and fixture business, an improvement of at least 25 per cent over last year's business is expected. As most of the tool shops did not work to capacity in 1923, except in the Detroit district, this would merely mean that the available tool shop capacity will be more fully used during the present year than for some years past. Manufacturers of vises expect a business at least equal to that of 1923, and one plant expects a 25 per cent increase.

The estimates in the forge shop equipment field vary considerably. The lowest estimate for the present year's business is 90 per cent of that of 1923, while the highest is from 150 to 200 per cent. One of the leaders in this field writes as follows: "Concerning business prospects for the year 1924, conditions appear to us to be very bright. Our sales for January are much greater than they were in January a year ago. Our volume of orders on the books is at its highest peak for two years. We contemplate increasing our plant capacity which will involve additional equipment."

In the molding machine field one of the most prominent concerns expects an increase of 25 per cent in sales during the present year. In the electric welding machinery field approximately the same business as in 1923 is looked forward to. In this field 1924 has started off at a much faster pace than 1923, and it is expected that the present year's business will exceed that of 1923 for the first six months, but it is believed that there may be a slackening during the latter part of the year so that the total will not differ much for the two years. One manufacturer in this field states that the sales appropriation to obtain the same volume of business will probably have to be from 15 to 20 per cent greater.

Summary of Opinions

Summarizing the opinions given by the leaders in the industrial field quoted in the preceding paragraphs, it may be said that the same volume of business is expected as in 1923. In the few instances where a smaller volume is looked forward to, the reduction is not more than 10 per cent, whereas in many instances an increase of from 20 to 25 per cent is expected. Most of the manufacturers whose opinions have been recorded, recognize the need of replacing their old equipment by new machinery in order to maintain their plant efficiency.

CURRENT STANDARDIZATION ACTIVITIES

Standard sizes of brass crucibles have been submitted for approval to the American Engineering Standards Committee by the Plumbago Crucible Association. These standard sizes have been developed by a committee originally under the auspices of the American Institute of Metals, consisting of representatives of users and of crucible manufacturers. The work was begun in 1913 and has gradually proceeded ever since. All but two crucible manufacturers who make crucibles for brass foundry use have now produced molds to conform with the new standard sizes adopted. Under this system the product of every crucible manufacturer will have the same outside shape, so that wherever they are used the same tongs and bails will fit all the crucibles.

Standard Sizes of Keys and Key Stock

The American Society of Mechanical Engineers is one of the sponsors for the work carried on to standardize keys and key stock. The proposed standards are given in the accompanying table in order to enable those interested to present criticisms and comments before final adoption. All communications should be addressed to C. B. LePage, assistant secretary, American Society of Mechanical Engineers, 29 W. 39th St., New York City.

PROPOSED STANDARDS FOR KEYS AND KEY STOCK

Shaft Diameter, Inches		Key, Nominal Size, Inches		Key Stock Sizes					
				Square Width and Thickness		Flat, Width		Flat, Thickness	
Over	To and Including	Square	Flat	Max.	Min.	Max.	Min.	Max.	Min.
7/16	11/16	1/8	1/8 by 3/32	0.125	0.123	0.125	0.123	0.094	0.092
11/16	7/8	3/16	3/16 by 5/32	0.1875	0.185	0.1875	0.185	0.156	0.154
7/8	1 3/16	1/4	1/4 by 3/16	0.250	0.248	0.250	0.248	0.1875	0.185
1 3/16	1 3/8	5/16	5/16 by 3/16	0.3125	0.310	0.3125	0.310	0.1875	0.185
1 3/8	1 11/16	3/8	3/8 by 1/4	0.375	0.373	0.375	0.373	0.250	0.248
1 11/16	1 7/8	7/16	7/16 by 5/16	0.4375	0.435	0.4375	0.435	0.3125	0.310
1 7/8	2 1/4	1/2	1/2 by 3/8	0.500	0.497	0.500	0.497	0.375	0.373
2 1/4	2 3/4	5/8	5/8 by 7/16	0.625	0.622	0.625	0.622	0.4375	0.435
2 3/4	3 1/4	3/4	3/4 by 1/2	0.750	0.747	0.750	0.747	0.500	0.497
3 1/4	3 3/4	7/8	7/8 by 7/8	0.875	0.872	0.875	0.872	0.625	0.622
3 3/4	4 1/2	1	1 by 3/4	1.000	0.997	1.000	0.997	0.750	0.747
4 1/2	5 1/2	1 1/4	1 1/4 by 7/8	1.250	1.247	1.250	1.247	0.875	0.872
5 1/2	6	1 1/2	1 1/2 by 1	1.500	1.497	1.500	1.497	1.000	0.997

Machinery

Gage Steel Standardization

The Gage Steel Committee, working in conjunction with the Bureau of Standards, has issued Communication No. 11, which is the seventh progress report of the gage steel investigation conducted at the Bureau of Standards. This report deals with solutions for quenching containing glycerin dissolved in water; estimates of cooling rates; and dimensional changes due to heat-treatment. It is shown that solutions of glycerin in water afford satisfactory quenching mediums which effectively cover the wide gap in cooling power that exists between oil and water. Copies of the report may be obtained by those interested, from the Gage Steel Committee, Bureau of Standards, Washington, D. C.

Bolt and Nut Standards

The Sectional Committee on the standardization of bolt, nut, and rivet proportions, consisting of a committee of manufacturers, users, and general interests organized under the auspices of the American Engineering Standards Committee, 29 W. 39th St., New York City, has published a tentative report covering proposed standard sizes of wrench heads, bolts, and nuts. A copy of this report may be obtained by addressing the American Engineering Standards Committee. Criticism and comment of all interested manufacturers and users of bolts, nuts, and wrenches are requested. Such comments should be addressed to C. B. LePage, American Society of Mechanical Engineers, 29 W. 39th St., New York City.

The committee has also prepared a report giving proposed standard dimensions for carriage bolts, including six types of heads, as follows: Common carriage bolt, button-head carriage bolt, fin-neck carriage bolt, ribbed carriage bolt, elevator bolt, and step bolt. Complete dimensions and formulas relating to this proposed standard will be found in the December number of *Mechanical Engineering*, published by the American Society of Mechanical Engineers. Criticisms and comments upon the proposed standard both from the point of view of the manufacturers of carriage bolts and the users of this type of bolts, should also be sent to C. B. LePage, at the address given in the foregoing.

Reducing Sizes of Forged Tools through Standardization

Recommendations for the elimination of nearly one-third of the styles and sizes of forged tools presented before a conference of manufacturers, distributors, technical societies, and consumers' representatives, held under the auspices of the Division of Simplified Practice of the Department of Commerce, has resulted in the adoption of a plan that will reduce the number of forged tools marketed for the use of blacksmiths, railroad construction workers, building trades, miners, etc., from 549 to 365. At present there are 163 different styles and sizes of anvils and blacksmiths' tools. Fifty of these will be eliminated.

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GREAT BRITAIN'S MACHINERY TRADE

The international machinery trade of the world is today largely divided between the United States and Great Britain. At the present time, Germany, France, Belgium, and Switzerland, together with a number of other countries, are furnishing only a comparatively small percentage of the world's machinery. Great Britain is both a large importer and a large exporter of machinery of all kinds. In 1922 the United Kingdom imported $21,500,000 worth of industrial machinery, of which the United States supplied over 65 per cent. The United States, in turn, imported $3,670,000 worth of British machinery, consisting to a large extent of textile machinery. It is in the textile field that the British manufacturers lead in export trade. In 1922 nearly 50 per cent of the total British machinery exports consisted of textile machinery. During the last few years the machine tool exports from Great Brita[i] have suffered a decline similar to that experienced in the United States. The exports during 1922 were 41 per cent less than in 1921. The figures quoted are given on the authority of special circular No. 371, issued by the Industrial Machinery Division of the Bureau of Foreign and Domestic Commerce, Washington, D. C.

PEWTER

The name "pewter" is given to a number of alloys of various metals in which tin is always the chief constituent. Generally, the alloy is composed of tin and lead. Thus, an alloy of 71.5 parts of tin and 27.8 parts of lead, or 78.2 parts of tin and 21.7 parts of lead, together with some impurities, is known as Roman pewter; but practically any composition of tin and lead, in which tin is the chief constituent, is known by the same name.

BOILER HORSEPOWER

The horsepower rating of a boiler is an arbitrary one and should not be confused with the horsepower unit of power representing 33,000 foot-pounds per minute. The standard boiler horsepower in the United States is the capacity to evaporate 30 pounds of water per hour from a feed-water temperature of 100 degrees F. into dry steam at 70 pounds gage pressure. This is equivalent to the evaporation of 34.5 pounds of water from a temperature of 212 degrees F. into steam at atmospheric pressure, which corresponds to a zero gage reading. Under ordinary conditions a boiler can be operated at 50 per cent over-rating at normal load and 100 per cent over-rating on peaks; the latter value means 69 pounds of steam per rated boiler horsepower instead of 34½. But 69 pounds from and at 212 degrees F. must be corrected for the pressure to be used and the temperature of the feed water. For general calculations, it is customary to figure a boiler horsepower at 30 pounds, and then add the percentage over-rating at which the boiler is expected to operate.

ACID-RESISTING ALLOY

An alloy which has resisted, when subjected to tests, the action of 25 per cent nitric acid for twenty-four hours without a measurable loss in weight, consists approximately of 6.5 per cent copper; 1.0 per cent of manganese; 1.0 per cent of silicon; 2.25 per cent of tungsten; 1.1 per cent of aluminum; 0.8 per cent of iron; 4.75 per cent of molybdenum; 21.1 per cent of chromium, and 61.5 per cent of nickel. The melting point of the alloy is approximately 2370 degrees F. When thoroughly liquid, the alloy pours readily and fills the mold perfectly, but the freezing point is so quickly reached that feeding of the casting from risers to make up for shrinkage is practically impossible, while the shrinkage is so excessive that cracks and hollow spots are very difficult to avoid. The material can be machined in a lathe about the same as tool steel. The tensile strength of the cast metal is about 50,000 pounds per square inch.

PUMP SUCTION

"Suction" is a term commonly applied to pumps to denote a decrease of atmospheric pressure within the inlet pipe and cylinder of a pump, as compared with the normal atmospheric pressure. During the suction stroke of a pump, which lifts water or some other liquid up to the pump cylinder from a lower level, the movement of the piston creates a partial vacuum within the cylinder on the inlet side, but as the normal atmospheric pressure is acting at the same time on the outer surface of the water with which the inlet or suction pipe connects, the water is forced upward because of the unequal pressure. What is commonly known as "suction," therefore, is, in reality, the forcing of water to a higher level by normal atmospheric pressure acting on a column of water connecting with a closed chamber or cylinder in which a partial vacuum has been formed.

PHOSPHOR-BRONZE

Phosphor-bronze is an alloy that contains copper, tin, and a small amount of phosphorus. It has a greater degree of strength and ductility than other simple bronze alloys, and can be cast, rolled, drawn cold, and forged. Phosphor-bronze is especially adapted for bearings and bushings where wearing qualities are desired, particularly for such parts as stuffing-boxes, linings, pump parts, propellers, etc. Its high elasticity makes it especially suitable for springs. It has a low electrical conductivity and a high corrosion resistance to salt water. Many machine tool bearings are made of phosphor-bronze. The important properties follow: Weight, 0.315 pound per cubic inch, 514 pounds per cubic foot. Specific gravity, 8.7. Strength: tension, 60,000 pounds per square inch; shear, 60,000 pounds per square inch. Melting point, 1760 degrees F.

LEVEL GLASS MOUNTING

The leveling glass or "bubble" of a level is generally fixed in a brass tube with plaster-of-paris. This method has been found to be satisfactory for all levels having an accuracy of about five seconds angular measurement to each one-tenth inch graduation. For finer levels, it is better to fix one end only with plaster-of-paris and the other with cork, because, if the glass is fixed rigidly at both ends with plaster-of-paris, there will be a strain on the level due to temperature changes, and, as the expansion of glass and brass is different, a slight inaccuracy is liable to result. It is also advisable to have an extra glass tube surrounding the leveling tube for very accurate levels, in order to provide insulation from the heat of the hand. A level of one minute angular measurement to one-tenth inch graduation is the most serviceable for general use. One having an accuracy of 30 seconds to one-tenth inch should be used on a floor free from vibration. Finer levels are used mostly on surveying and astronomical instruments.

MALLEABLE CAST IRON

Malleable iron possesses physical properties closely resembling those of wrought iron, and as it is primarily a cast metal, odd shapes, housings, etc., may be made which possess, to a marked degree, the properties of forged metal. The tensile strength of malleable iron is much higher than that of cast iron and being ductile it offers considerable resistance to sudden shocks and strains. It is quite possible to manufacture malleable iron having a tensile strength of 50,000 to 60,000 pounds per square inch and an elongation of from 12 to 16 per cent in two inches. There are two definite steps in manufacturing malleable iron—the casting and the annealing. The "white-iron" castings to be annealed are packed or embedded in rolling mill scale in iron pots, which are normally open at the top and bottom. It is customary to arrange these pots three high in the oven. In sets of three high the cold oven is filled to capacity, the doors are closed and sealed with fire-clay, and the fire is started. The purpose of the scale is to keep the fire from direct contact with the castings. The temperature is raised to between 1400 and 1700 degrees F. and is maintained there for forty-eight hours or longer; then the fire is allowed to die out and the oven cools slowly. As it ordinarily takes two days to obtain the required temperature, the whole process may require eight days from the time the fires are started until the castings are removed. It is essential that the oven be cooled very slowly from its high temperature, as this is a determining factor in the quality of the product.

STEAM SEPARATORS

Steam separators are used in steam power plants in order to intercept the moisture in the steam and the water of condensation that flows along with it, before the steam reaches the engine cylinders or turbines, thus protecting them from damage by water. It is a well-known fact that steam engines and turbines operate more economically and at higher efficiency when supplied with dry steam than when supplied with moisture-laden steam. For this reason, a steam separator will effect a saving in fuel and also a considerable saving in oil and engine repairs.

ROYALTY CONTRACTS

Royalty contracts are usually made on the basis of the inventor receiving a certain per cent of the retail selling price, or in some cases a percentage of the price obtained by the manufacturer. A much better arrangement is an agreed amount per article. In some cases the inventor agrees to take a certain proportion of the profits. This is usually a very poor arrangement, as the inventor is in effect and usually in fact a partner, and may become liable for the debts of the business; and in any case he has to find out what the profits are, which is often a matter for much argument and contention. The manufacturer should agree to keep an accurate account of the number of articles sold and to report and remit at stated times. He should also agree to allow the inventor free access to his books during business hours, and should agree to swear to the correctness of the books and the reports if required to do so by the inventor. Sometimes it is possible to give the articles consecutive serial numbers, which makes the accounting easier, and sometimes the inventor furnishes nameplates or labels at so much apiece, which the licensee affixes to the article. The main considerations are to see that the contract is definite as to what is to be done, and the exact time that it is to be done, and to provide that if it is not done, all rights shall revert to the inventor.

SPELTERS FOR BRAZING

The spelters employed in brazing are composed of alloys of copper and zinc. The melting point of copper-zinc alloys may be regulated by varying the percentage of zinc, the melting temperature decreasing as the proportion of zinc increases. The fusing point of spelters should be as close as possible to that of the article to be brazed, as a more tenacious joint is thereby secured. An easily fusible spelter may be made from two parts of zinc to one part of copper, but the joint will be weaker than when a spelter more difficult to fuse is employed. A readily fusible spelter may be made with 44 per cent of copper, 50 per cent of zinc, 4 per cent of tin, and 2 per cent of lead. Alloys containing much lead, however, should be avoided, since lead does not transfuse with brass and thus decreases the strength of the joint. A hard spelter for the richer alloys of copper and zinc may be produced from 53 parts of copper and 47 parts of zinc. Brass spelter is sometimes used for copper and iron articles, as these metals have a much higher melting point than brass, thus allowing the use of a richer copper alloy. In these cases tin is often added as one of the ingredients, but it should be sparingly used as it increases the brittleness of the spelter. Ordinarily the spelter solder used for brazing is obtained from manufacturers of such supplies. In making brazing spelters, it is important that the metals used should be commercially pure, as impurities interfere with the color, malleability, and strength.

JARNO TAPER

The Jarno taper was originally proposed by Oscar J. Beale of the Brown & Sharpe Mfg. Co., Providence, R. I. No table is necessary for the Jarno taper socket, as this socket is based on such simple formulas that practically no calculations are required when the number of taper is known. The taper per foot of all Jarno taper sizes is 0.600 inch on the diameter. The diameter at the large end is as many eighths, the diameter at the small end is as many tenths, and the length as many half inches as are indicated by the number of the taper. For example, a No. 7 Jarno taper is 7/8 inch in diameter at the large end; 7/10, or 0.700 inch at the small end; and 7/2, or 3½ inches long. The Jarno taper is used on various machine tools, especially profiling machines and die-sinking machines.

PARAFFIN- AND ASPHALT-BASE OILS

The comparative value of paraffin- and asphalt-base oils is often discussed, though most lubricating oils come from stocks containing both bases, and it is doubtful if the average engineer could tell which he is using, if there were no label. Paraffin oils stand warming slightly better than asphalt-base oils, but freeze solid when subjected to temperatures at which the latter remain liquid and capable of giving good service. There is no perceptible difference in their chemical stability, both breaking up and depositing heavy tars at about the same temperatures. The most stable hydrocarbons, such as kerosene, benzol and benzol-oils are not good lubricants, while the least stable, or heavier hydrocarbons are the best lubricants. It is claimed by several of our best chemists that the quality of oiliness or slipperiness comes from the very fact that the oil is not stable, but composed of unstable or unsaturated compounds. Therefore an oil cannot be both stable and a good lubricant, which is apparent from the fact that no hydrocarbon whose composition is definitely known to be stable is a good lubricant. This is the reason why it is difficult to obtain good lubricants for high temperatures. An oil that will stand the temperature is not as "oily" as some of the less stable oils used at lower temperatures.

BOILERS OF THE WATER-TUBE TYPE

Water-tube boilers are so named because the water is inside the tubes, which are surrounded by the hot gases. This gives a more rapid circulation to the water, which increases the efficiency of the heating surface. In addition, the large amount of surface exposed directly to the fire increases the transmission of heat and prevents overheating. The draft area, sometimes constricted in fire-tube boilers, is always ample in this form, which gives a slower movement to the gases and allows more time for the absorption of their heat by the water. Other advantages are the rapidity with which steam may be raised, owing to the water being divided into a large number of small streams which pass through the hottest part of the fire, and also the safety due to the same cause, the division of the water into small masses preventing serious results in case of rupture. Water-tube boilers are made both horizontal and vertical in form, the tubes in the former being inclined upward toward the front in order to assist in the circulation. When properly constructed, the different surfaces are easily reached for cleaning, and being made up of comparatively small parts, are easily transported and erected. The principal disadvantage is the small amount of water space, which limits the reserve capacity in case of sudden calls for steam.

The British Metal-working Industries

From MACHINERY's Special Correspondent

London, February 8

ALTHOUGH it is agreed that a definite improvement has set in, many industries are not justifying all the more sanguine hopes of a few weeks ago. Several factors, though individually unimportant, have together caused a setback, which, however, is generally felt to be temporary. For example, the beginning of the year is a favorite period for stock-taking, and this often results in a slackening of business. At the same time labor troubles have again come to the surface, and although the strike of locomotive engineers and firemen that occurred some weeks ago lasted only a little over a week, freight has been held up seriously in transit. The dock-workers have threatened a strike, and trouble is again brewing among the miners.

The production of coal in Great Britain last year was greater than in any year since 1913, while the output of pig iron was 72 per cent of the 1913 figure and 51 per cent greater than in 1922. The output of steel last year was 10 per cent greater than in 1913. During 1923, the railways of Great Britain carried more passengers and a greater tonnage of goods and merchandise than in pre-war years.

The Machine Tool Industry

In some districts, notably the Midlands and Scotland, machine tool works are filling up in a very satisfactory manner. In other districts, orders are being placed steadily, although the big improvement noticeable in November and December is not maintained. Among general-purpose machines, radial drilling machines, milling machines, and lathes are in good demand. Turret lathe and screw machine makers are generally busy and have sufficient orders to last them well into the spring; one of the largest makers of these machines in the Midlands is running at full capacity night and day. Among recent contracts the firm just referred to received one for thirty-five combination turret lathes ranging from 12 to 16 inches swing. These machines are for a Continental automobile works and represent, apart from war-time contracts, the largest order received by this firm. There are several other instances where the British machine tool industry is benefiting from French developments in automobile car production. British automobile firms also continue to be good customers in the home machine tool market, and gear-cutting machines are prominent among recent orders.

Recent orders of a substantial nature have been placed for grinding machines, lathes, and other tools required for railway shop developments. Rolling stock builders, in view of the large contracts in hand, are active inquirers for machine tools. Makers of jigs and fixtures are satisfactorily occupied, the bulk of the work in hand being for automobile manufacturers.

Overseas Trade in Machine Tools

The returns for December showed a further fall in machine tool exports from the tonnage peak of 1675 reached in October. The corresponding value also showed a fall. The export tonnage during December was 1166 with a value of about $550,000 or about $450 per ton, while the imports of machine tools reached a tonnage of 269 only, with a value of about $195,000, or about $720 per ton. The total exports for 1923 were 14,149 tons with a value of $6,600,000.

Taking the average export tonnage of machine tools for the years 1911 to 1914 as 100, the corresponding figures for 1922 and for 1923, were 80 and 92, respectively. The advances made in the export trade of machine tools during 1923 were erratic, and the total, together with the home demand, was quite insufficient to give full employment to the increased productive capacity of the industry as a whole. During 1923 the export value of small tools reached a third of the value of exported machine tools and amounted to $2,200,000—a figure comparable with the pre-war export value of these articles.

General Engineering Field

The position in nearly all branches of engineering shows a marked improvement. Public works schemes are in hand all over the country, several large factories are being built, and important bridge-building contracts are in hand for home railways and public corporations. As a result, constructional engineers are in many cases working to capacity. Rolling stock makers in the Midlands are fully employed and regard future prospects as most encouraging. The hydro-electric department of Vickers, Ltd., Barrow-in-Furness, has received an order for the largest single-runner Francis water turbine yet built in England. This is a 25,000-horsepower water turbine to be installed at Calumet Island on the Ottawa River in Canada. Eventually three more similar units will be installed.

In the electrical industry, most firms are in a satisfactory position. Ferranti Ltd., of Hollinwood, have been commissioned by the Tata Power Co. of Bombay to install four banks of 30,000 K.V.A. transformers, and these constitute the largest yet built in this country. It is anticipated that the order will be repeated for other overseas destinations.

Firms making small accessories for the engineering trades are busy, and it may be noted that belt manufacturers in many cases exceeded in December, the average output for other months of last year by 25 per cent. Firms specializing in power transmission equipment also report a steadily improving trade, and some are working at capacity.

Shipbuilding

Conditions in the shipbuilding industry continue to improve, although the amount of shipbuilding has not jumped phenomenally. On the Clyde all the yards started the year with a fair amount of work in hand, and the reopening of three yards in Greenock and Glasgow is to be noted. In the Newcastle yards, inquiries are much more numerous, and several orders, mostly for small vessels, have been received.

The shipping actually under construction in this country at the end of December, 1923, amounted to 1,231,000 tons. The average tonnage building during the twelve months immediately preceding the war was 1,890,000 tons, or 659,000 tons more than the present total. There are now under construction in Great Britain and Ireland two motor vessels between 15,000 and 20,000 tons, whereas only one motor ship of this size was being built at the end of September, 1923, and three motor ships of between 20,000 and 25,000 tons are now being built, as compared with two on September 30, 1923.

Labor Conditions

Employment in all the engineering industries during December was distinctly better than in November. The most marked improvement was in the automobile field, and the most unsatisfactory returns came from the textile engineering industry. The total number of unemployed in the engineering industries during December was approximately 157,000, a decrease of about 15,000 from the previous month.

Fixtures for Production Milling

By ALBERT A. DOWD

ANY milling fixture, to be satisfactory, must be so arranged that it will locate the work positively, hold it firmly while it is being milled, and operate with a minimum amount of labor. If a fixture is so made that it requires considerable time to set up the work properly, production will be decreased correspondingly, and the cost of machining each piece will be increased. Modern production methods require substantial fixtures to insure rigidity and freedom from chatter under high speeds and coarse feeds.

Fixture of Bridge Construction

In this article several examples of fixture design are given in detail to illustrate the modern trend in locating and clamping methods and in general features of construction. Fig. 1 shows a gear-shift shaft forging which has previously been machined at *A*, *B*, *C*, *D*, *E*, and *F*. The fixture shown in Fig. 2 is designed for use in milling the ¾-inch radius cut *G*, the work being located by the previously machined surfaces *A*, *B*, and *F*. In taking a cut as heavy as this, it is essential that the work be supported rigidly at the points where the cutting action takes place. The cylindrical portions *A* and *B*, from which the work is located, rest in V-blocks *H* and *I*. The end location is against surface *J*, and the fork is trued up by turning the knurled screw *K* to force the work over until it strikes stop-screw *L*. It is pulled back rigidly against a solid surface by the action of the two hook-bolts *M* and *N* on opposite sides of the work. As the nuts *O* and *P* are tightened by a wrench, a rigid method of holding is obtained. The cutter *Q* mills the radius form *G* as the table moves forward.

The general features of construction of this fixture are considerably out of the ordinary. The base *R* is an iron casting having a general U-form. It has a ledge along one side at *V* and a pad at *W* for aligning the V-blocks *H* and *I*. The two heavy lugs *S* and *T* act as supports for the steel block *U* which bridges the fixture and ties it together. A shoulder *X* is so placed as to take the thrust of the cut away from the screws that hold the block in position, thus forming a rigid construction. A fixture of this kind allows rapid location and substantial holding of the work, and is easily cleaned.

The fixture shown in Fig. 3 is another example of a bridge-construction fixture with several novel features for locating and clamping. The part for which this fixture is intended is shown, on a larger scale, in the upper right-hand corner of the illustration. The operation consists of milling the 0.628-inch slot *A* across the large end of the work. Two pieces are dropped at a time into pockets in the bridge of the fixture, as indicated by the dot-and-dash lines, and "spun" down on the threaded studs *B* by hand. The knurled knob *D* is then tightened, which causes the equalizing member *J* to pull down studs *B* until the work is securely seated. The base, like that of the preceding example, is U-shaped, bridged across and tied together by the steel block *M*. Shoulder *N* takes the thrust of the cut and relieves the holding screws *O* of undue stresses.

The lower portions of the threaded studs *B* enter pockets in the base of the fixture, and are supported by stiff springs *C*. The studs are also grooved to receive the forks of the clamping member. The forks are rounded slightly at *E* to allow for height variations and to insure a firm bearing. A pin *F* runs entirely through the fixture and acts as a pivot for the clamp, which, incidentally, has only a short bearing at *X* (see plan view) for equalizing purposes. Knob *D* has a threaded stem which passes through the end of the clamping member, and the hardened stud *K*, set in the base of the fixture, takes the thrust from the end of this thumb-screw. In order to prevent studs *B* from turning, blocks *G* are fastened to the under side of the bridge block *M*, the ends of these blocks acting as keys in slots *P* milled in the sides of the studs. The ends of slots *P* limit the upward movement of the studs.

The hardened and ground strip *L* is ⅛ inch below the surface to be milled, thus allowing the use of a ⅛-inch size block in setting the cutters to the proper height. This fixture is rapid in its manipulation, allowing the work to be set up and removed in a minimum amount of time. The clamp is so constructed that an equalizing effect is produced, both of the pieces being held at approximately the same pressure. The work fits snugly into the recesses of block *M*, and as the clamp pulls the work down, the pieces are held so firmly that they almost become part of the fixture, thus allowing heavy cutting to be done.

Fig. 4 shows detail views of a cast-steel shackle bracket on which the bosses which act as bearings are to be straddle-milled on surfaces *A*. Surfaces *B* and *C* have previously been machined, so that they can be used for locating the work. The fixture used for this part is illustrated in Fig. 5, two pieces being located and clamped ready for milling at the same time. The fixture is so arranged that after setting the work in position against the stop-pins *D*, as indicated by the heavy dot-and-dash lines, the handwheel *T* is operated, tightening four clamps at one time and thus holding the work securely.

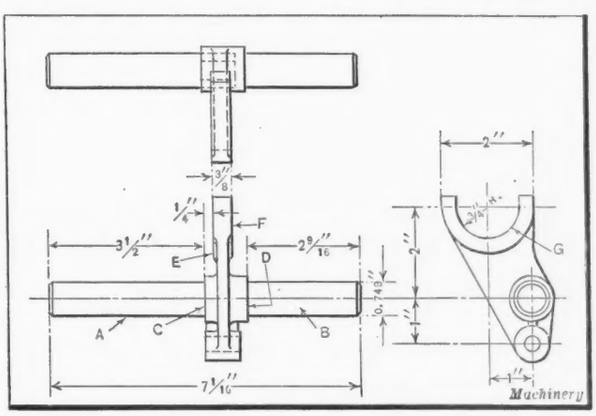

Fig. 1. Part for which Fixture shown in Fig. 2 was designed

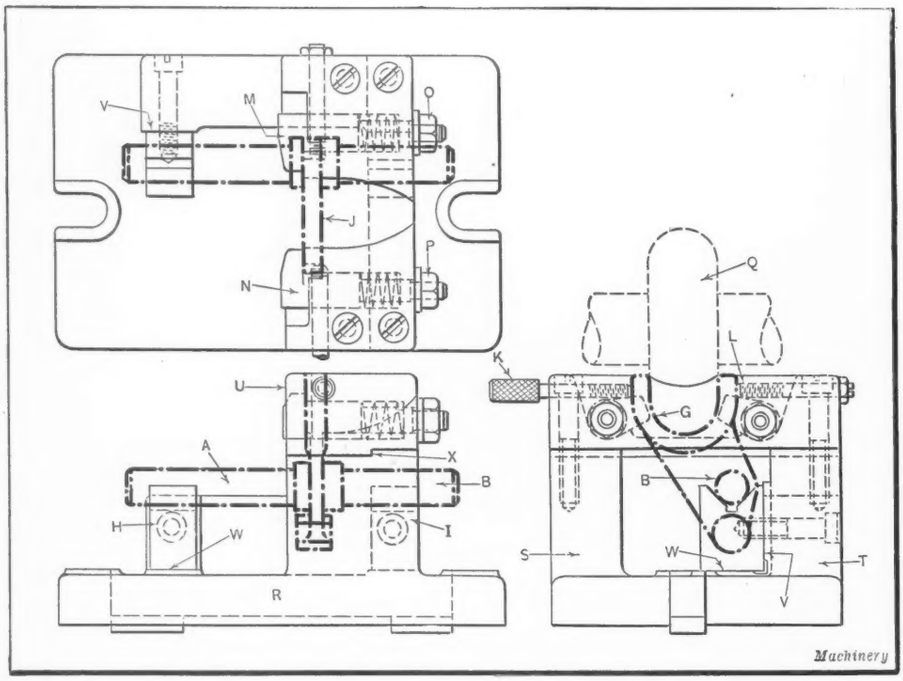

Fig. 2. Fixture used for holding the Gear-shift Shaft Forging shown in Fig. 1, while milling Surface G

Body *G* of the fixture is located and clamped to the milling machine table in the usual way, and is cored out underneath to reduce the weight. There are three longitudinal holes through the body of the casting, the central one receiving the operating rod *H*, on one end of which is the double-ended clamp *L*, and on the other the handwheel *T*. The handwheel is threaded to fit an Acme thread of 6 per inch cut on the operating rod. The long hook-bolts *E* on each side of the fixture pass entirely through the other two longitudinal holes, and a handle *S* is provided on each one to allow the hook-bolts to be turned a quarter of the way around when inserting or removing work.

Cams *M*, through which the hook-bolts pass, have an angular slot *N* cut through them, in which pins *O* seat themselves. The upper ends of the pins are rounded and bear on the under side of hardened buttons *P* which are inserted in the clamps *F*. The latter are forked at one end to straddle the work as shown, and they are pivoted on the special studs *Q*. Clamp *R* bears at each end against the ends of cams *M*. The operating and hook-bolt rods pass through the clearance holes shown in the clamp. The hook-bolts and the cams are restrained in their movements by screws *V* and *U*, respectively, slots being cut in the movable members. The slot for screw *V* extends one-quarter of the way around the hook-bolt to permit a circular movement. Springs are provided at *W* and *X* for releasing purposes.

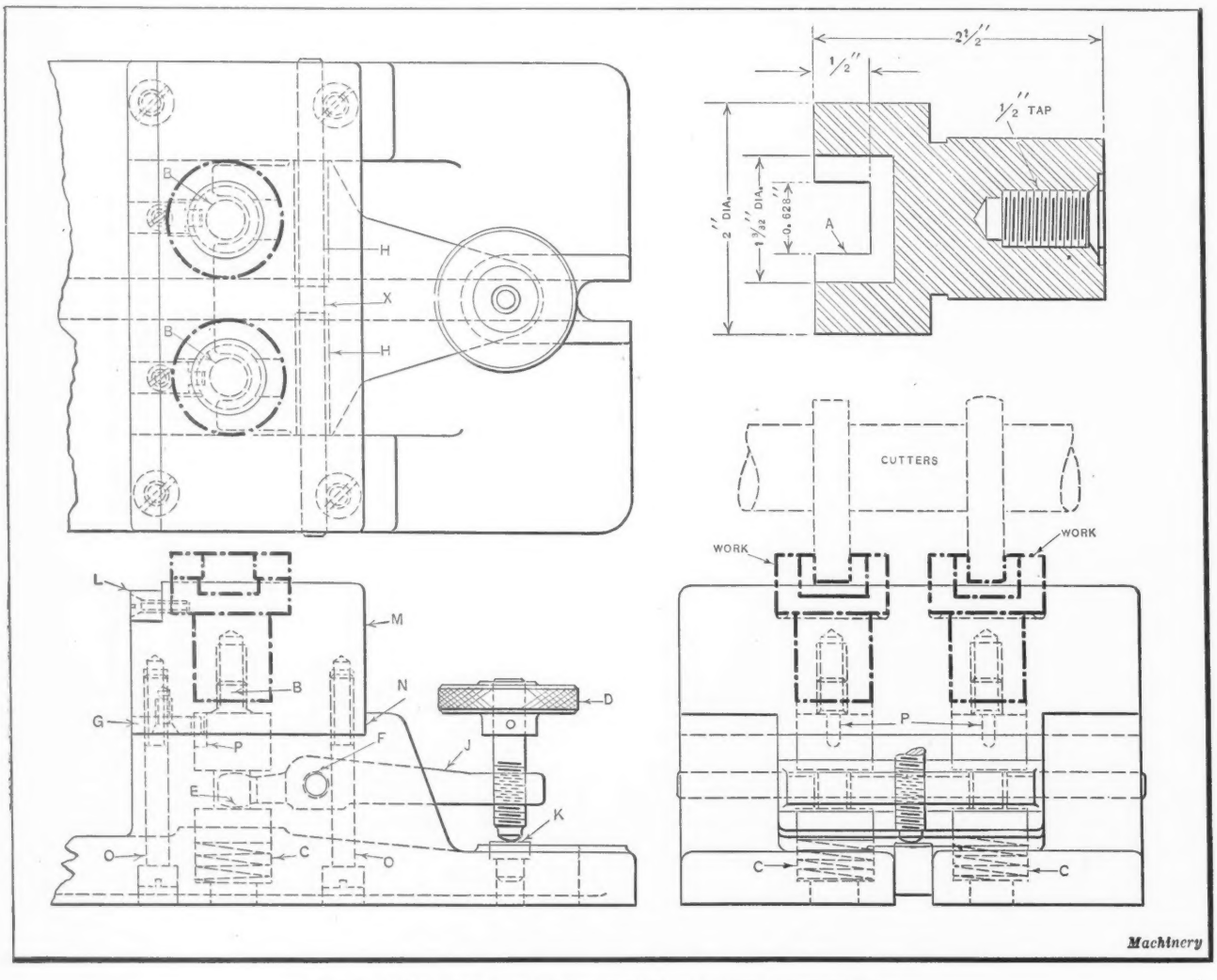

Fig. 3. Twin Slot-milling Fixture provided with Novel Clamping Means

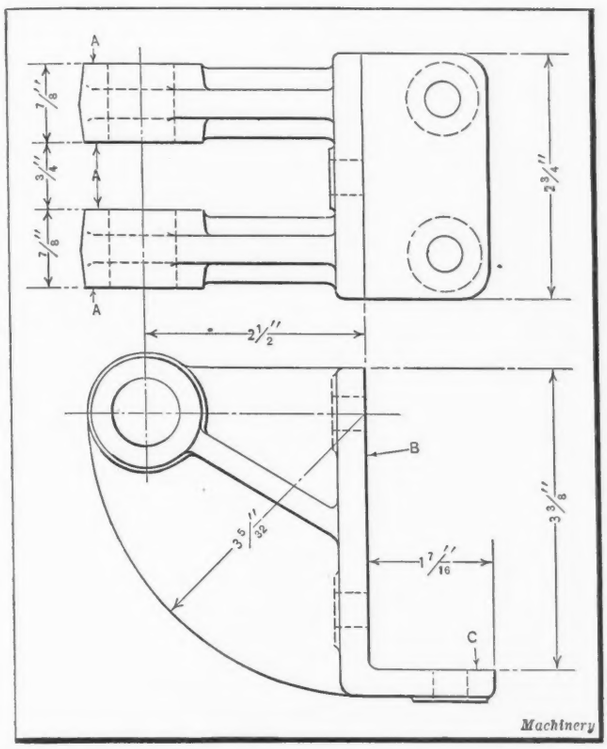

Fig. 4. Shackle Bracket on which the Bearing Faces are straddle-milled in Fixture shown in Fig. 5

The action of the mechanism is as follows: After the work has been placed in position and located against the stop-pins, the operator revolves the handwheel in a right-hand direction, thus drawing on the operating rod *H* and causing clamp *L* to exert pressure against ends *E* of the hook-bolts. The same movement of the handwheel also presses clamp *R* against the ends of both cams *M*, which, as they travel forward, raise pins *O* and force the other ends of clamps *F* down on the work, clamping it down against locating pad *B* and also against pad *C*. As the feed of the table is in the direction of the arrow, the pressure of the cutter against the work is obviously in the reverse direction, which is resisted by the heel of the work against pad *C*. There is an equalizing action on the various clamps so that the pressure is distributed in the same way each time the work is clamped. On account of the leverage, the pressure on clamps *F* is somewhat greater than that on the hook-bolts *E*, but this is not important.

The advantage of fixtures of this and the preceding types is rapidity of operation, combined with the practically "fool-proof" features which make the setting up easy and the likelihood of errors small. The operator's safety is also a valuable consideration, as he is not obliged to put his hands near the cutters in setting up or removing the work. It may be argued that the fixture is expensive to build, but for high production the extra expense over a cheaper fixture is more than repaid by the time saved in setting and clamping the work.

* * *

There were twelve machine tool factories in operation in Poland during 1922, employing in all 1660 workmen, according to a Commerce Report. The total production was insufficient to meet internal needs.

ADVANTAGES OF LARGE PULLEYS

By N. G. NEAR

When buying pulleys it should be remembered that the larger sizes usually give better satisfaction and are less expensive in the long run than small ones. A pulley that is too small in diameter will not pull the required load unless the belt is drawn up tight. For instance, a 12-inch pulley may require a belt tension or belt pull of 2000 pounds. This is a heavy pull and certainly necessitates a wide belt whether of single, double, or triple ply. Now if this pulley runs at a speed of only 300 revolutions per minute, the belt speed will be 950 feet per minute, which is entirely too low. In such cases, a much larger pulley should be used.

Suppose, now, that the 12-inch pulley is replaced by a pulley 24 inches in diameter. The belt pull immediately drops to one-half what it was, which means that a belt one-half as wide will do the same work and will do it better. There will be less friction of the bearings and less slippage, the first cost of the belt will be less, and there will be a saving in power and maintenance cost. In addition to these advantages, the life of the belt will be much longer. In fact, there will be a saving in every way except in the space occupied by the pulley. However, this is not usually of much importance, as the pulleys are generally mounted on shafts suspended from the ceiling so that they are out of the way.

It is not necessary to restrict the diameter of the pulley in this case to 24 inches, as the belt speed with this size of pulley is only 1900 feet per minute whereas 4000 feet per minute is not considered excessive. If a pulley 48 inches in diameter is used, the resulting belt speed will be well within the safety limit. With a pulley of this size the belt pull will be reduced to only 500 pounds and the belt will need to be only one-quarter as wide as with the original 12-inch pulley. Also the possibility of belt slippage is practically eliminated and the initial tension is reduced nearly to zero. Belts should run as slack as possible; a free easy-moving high-speed belt is always desirable.

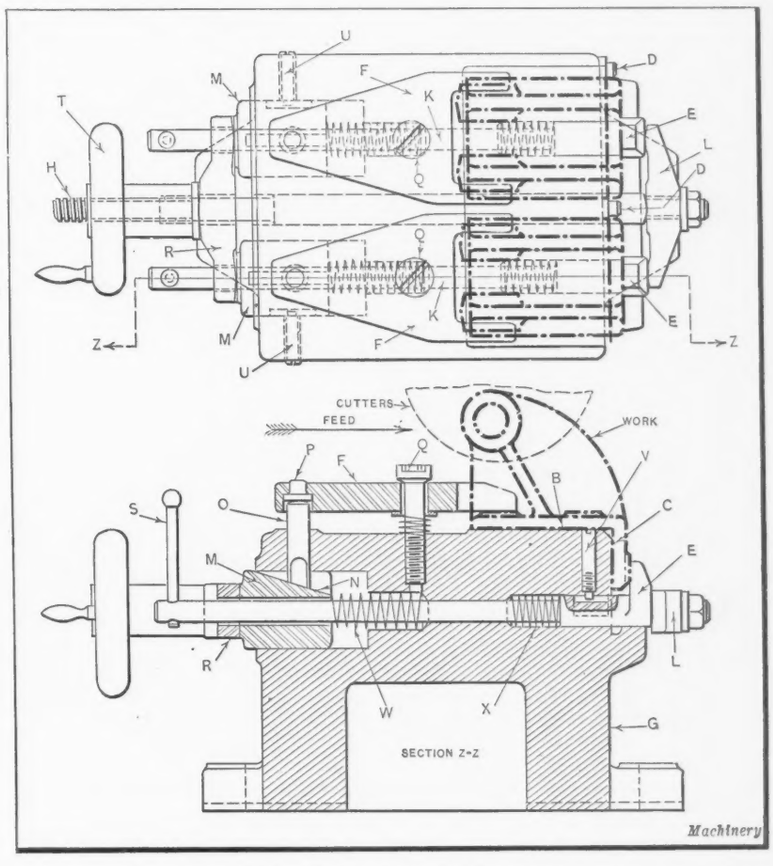

Fig. 5. Twin Milling Fixture with Equalizing Clamping Features

Helping the Worker by Education

How the Evening School at the Pittsfield Works of the General Electric Co. Provides Educational Opportunities for the Employes

By S. W. ASHE

MANY large factories are located in communities like Pittsfield, a city of 45,000, where no educational facilities more advanced than a high school are available, except possibly a few evening classes, and where there is a real need for higher education among factory people. To meet this condition, the writer who is the head of the educational and welfare work at the Pittsfield plant of the General Electric Co., gave a series of ten experimental lectures on electricity ten years ago, which served to awaken a real interest in education among the employes of the plant. These lectures were given at a theater, and over 1000 people attended each of the first five lectures, the average attendance for the whole course being well over 800. At the expiration of these lectures a course in mechanical drawing was started, the head of a drafting department who had had experience as a teacher being made instructor. A small fee of $5 was charged for the course to limit it to those really interested, but the fee was rebated at the end of the course for a passing mark of 75 per cent.

The author of this article has organized and developed the educational work here outlined, in conjunction with his other educational and welfare activities. He has had a wide and successful experience as a teacher and lecturer; he is a graduate of Cooper Union, and of the Polytechnic Institute of Brooklyn, where he taught twelve years before taking up post-graduate work at Columbia University. It was largely through his efforts that the evening technical school at the Brooklyn Polytechnic Institute was formed years ago. He also lectured several years for the Brooklyn Edison Co., the New York Edison Co., the Boston Edison Co., and the Consolidated Gas, Electric Light and Power Co. of Baltimore. Before going to Pittsfield, he spent three years at the plant of the Edison Lamp Works, in Harrison, N. J., organizing a sales training course.

Growth of the School

The course was limited to twenty two-hour sessions, one given each week. Later the class was divided into two sections—an elementary and an advanced section, each of which met one evening a week. Both groups could attend both meetings, but one class was devoted to elementary work, while the other took up advanced work. Interest in this course was maintained from the beginning with the result that a new course in elementary electricity with laboratory work was formed, the writer's book on elementary electricity being used as a text-book. A small room was furnished as a laboratory with discarded equipment and instruments borrowed from the plant's laboratory. There is always a certain amount of electrical equipment about the plant, such as motors, transformers, and wiring devices, which is obsolete, but which is satisfactory for instruction purposes and for tests, and this type of equipment has been used for class instruction.

This class in electrical laboratory work was also successful and so a course in algebra and geometry was started. Each year new courses have been added and old courses rearranged to fit the conditions, and so the school has grown until there is now an enrollment of 300 pupils in sixteen classes. These classes consist of mechanical drawing; algebra and geometry; blueprint reading, curve plotting, slide-rule instruction; vector analysis; elementary electricity; direct- and alternating-current laboratory work; direct- and alternating-current theory; transformer design; typewriting; machine shop practice; properties and uses of materials; safety engineering; analytical geometry; public speaking; health nursing; and metal spinning.

Instructors of the School

All the instructors with the exception of the class in public speaking are regular employes who have been carefully selected because of their aptitude for the subject taught, and because of natural enthusiasm and interest in evening course work. The test of a good evening course teacher is his ability to hold his students and the extent to which he follows them in their daily work and helps them make progress in the organization.

A flat enrollment fee of $5 is charged for each course taken, and the fee is rebated, as in the original course, with a passing mark of 75 per cent. Some of the classes have one-hour sessions and others have two-hour sessions. Many instances could be cited of employes engaged in routine mechanical tasks who developed, through these courses, so that they were able to go into the engineering departments. One ambitious office boy in a period of three years became an able junior engineer through attending the evening classes. The classes are held at 5:15 P. M., immediately after working hours, which enables a student to complete his studies early and

EVENING CLASS SCHEDULE--1923-24

Class	Instructor	Monday	Tuesday	Wednesday	Thursday	Friday
MECHANICAL DRAWING	E. J. CHANDLER		RESTAURANT			RESTAURANT
ALGEBRA & GEOMETRY	E. U. BROWN	APPRENTICE				
BLUEPRINT Reading, Curve Plotting	W. KNAPP			PIECE RATE Dept.		
VECTOR ANALYSIS	A. BOYAJIAN	BLDG. 16				
ELEMENTARY ELECTRICITY	H. R. TURNER		APPRENTICE			
D.C. & A.C. THEORY	C. H. KLINE			BLDG. 16		
D.C. & A.C. LABORATORY	M. G. NEWMAN					BLDG. 7
TRANSFORMER DESIGN	C. H. KLINE				RESTAURANT	
TYPEWRITING	MISS. N. WILLIAMS	PRODUCT. Office		PRODUCT. Office		
MACHINE SHOP PRACTICE	A. PHINNEY	APPRENTICE				
PROPERTY & USES of Materials	H. W. TOBEY			LABORATORY		
SAFETY ENGINEERING	S. W. ASHE	AUDITORIUM				
ANALYTICAL GEOMETRY	A. GODIN		BLDG. 16			
PUBLIC SPEAKING	KATHERINE CANADA		AUDITORIUM			
HEALTH NURSING	EDITH LACEY			BLDG. 16		
METAL SPINNING	Wm. H. Northwood Wm. D. Kelly				BLDG. 41	

Schedule of Classes for the Term 1923-1924 at the Evening School of the Pittsfield Works of the General Electric Co.

have the remainder of the evening free for other purposes. The instructors are all paid a fee of $5 an evening; the expense of maintaining the school during the present term will amount to about $1800.

Many of the laboratory courses given are equivalent to junior laboratory work in college and are of such a high grade that the university extension course of Massachusetts is willing to give certificates for them, even though, in many cases, they are not their own courses. No special facilities are provided for the classes, use being made of the regular drawing rooms, offices, and laboratories of the plant, and available classrooms in the apprentice department.

Some of the other courses of value to the student, which he could not otherwise obtain in the community, are: Machine shop practice for office and production employes; metal spinning for beginners; public speaking for engineers and executives; properties and uses of materials used in manufacture, such as oils, insulation, steel, wood, etc.; and blueprint reading. When the course in metal spinning was started this year, two able spinners were selected to teach, and the course is being developed by these men from the ground up, as no courses of this nature seemed to be available anywhere. When it is about time to enroll, a systematic publicity campaign is started each year to get students to enroll. Their fees are deducted from the pay envelope weekly in small amounts. Two dollars is deducted for each course the first week and one dollar each succeeding week, until the five dollars is collected.

Electroplating Equipment by Means of which Wrench Handles are nickel-plated automatically

The evening course work is part of a broad educational scheme carried out at the Pittsfield Works, including a works' paper—*Current News*—an apprentice school, educational talks and moving pictures at noon, and lectures once a week to college men on test. The success of all this work has been due largely to the fact that it is operated so as not to interfere with production in any way and so as to utilize employes themselves in running the school.

* * *

IMPORTS OF MACHINERY INTO ITALY

The industrial machinery trade of Italy is dealt with in Trade Information Bulletin No. 169, recently published by the Industrial Machinery Division of the Bureau of Foreign and Domestic Commerce, Washington, D. C. This bulletin gives complete statistical information relating to imports of industrial machinery into Italy in 1922, and also contains comparative tables of imports as far back as 1910. The machinery imports into Italy in 1922 approximated a value of $19,000,000. Germany supplied one-half of the imports, Great Britain about 15 per cent, Switzerland about 10 per cent, and the United States only about 7 per cent. It is pointed out that at the present time the German prices, which are now quoted in dollars or pounds sterling, have risen to such an extent that German competition is no longer as formidable as it has been, and there is a possibility for American manufacturers of various classes of machinery to enter this market.

AUTOMATIC ELECTROPLATING INSTALLATION

To accommodate the large volume of wrench handles that are nickel-plated at the plant of Walden-Worcester, Inc., Worcester, Mass., there has been installed an electroplating unit which is automatic except for loading and unloading. The parts are raised and lowered by the equipment into the various tanks required for the operation, remaining in each tank a certain length of time which has been found to give the desired results. The equipment is about 50 feet long, and thirty minutes is required for the work to traverse the circuit.

The wrench handles are attached to cross-bars on the lower ends of long vertical bars *A*, as shown in the accompanying illustration. These bars are carried around the installation by two conveyor chains which run on tracks *B* and *C*, and which are driven by a motor at the far end through gearing. The bars are spaced at intervals of about 1½ feet along these chains, and there are two rollers between which they slide up and down, in order to lower the work into the tanks and raise it from them. The vertical movements are obtained through a roller *D* on each bar, which travels on a track *E* having slanting sections for raising and lowering the work, and straight sections for carrying it on to the different tanks.

The first tank into which the wrench handles are lowered after being placed on the carrying bars contains a solution of potash, which is heated by means of a steam-pipe coil at the bottom of the tank. The next tank contains an acid for cleaning off rust, etc., from the parts; after leaving this tank, the work is immersed in a running cold water bath to remove all traces of the acid. In the third tank there is a copper solution, which is also steam-heated, and as the work comes from this tank, it is dipped into a second cold water bath to remove excess copper solution before nickel-plating. The latter operation is conducted in a tank that is approximately the length of one side of the equipment, and so consumes about fifteen minutes. From the nickel-plating tank, the wrench handles are once more dipped into a cold water bath, and then into hot water so that they will dry quickly when removed from the carrying bars.

A four-horsepower motor furnishes ample power for driving the conveyor chains, the drive from the motor being first to a jack-shaft and then through a pinion to a large bevel gear on the upper end of a vertical shaft. On this shaft there are two sprockets, one for driving the upper conveyor chain, and the second for the lower chain. While the work is in the copper and nickel-plating tanks, the necessary electric current is supplied by having a special device at the top of each bar *A* ride on a bus-bar above the tank. Then the current flows down bar *A* and through each part to electrodes attached to the sides of the tanks. An electric generator driven by a 25-horsepower motor provides the current for the operations.

Interlocking Devices

Second of Three Articles Descriptive of Interlocking Devices Used on Machine Tools

By ALBERT CLEGG

THE first installment of this article which appeared on page 446 of February MACHINERY dealt with three styles of interlocking devices adapted for use on machine tools and for general use on machines requiring mechanisms of this kind. In the present article several types of interlocking devices designed primarily for use on lathes are described.

Interlocking Device for Lathe Apron

Lathe aprons are usually fitted with some arrangement for interlocking the conflicting gear mechanisms. In some cases the cross and longitudinal feeds are not so treated, provision being made to prevent the engagement of the lead-screw nut when either of the other two feeds is in use, though there is nothing to prevent the simultaneous engagement of the two feeds themselves. Logically, this system does not appear to be right; all three motions ought to be interlocked so that no one interferes with any of the others. The design shown in Fig. 5 is of the type referred to above, the only interlocking action being between the lead-screw nut and the feed combinations.

The feeds are engaged by a drop-worm, carried in box *A* and engaged by handle *B*, the trigger *C* holding the drop-worm box in the engaged position. The square rod *F* has a slight endwise movement, and is cut away near the worm-box to provide a support for trigger *C*. To release the feed, the rod is moved to the right by means of handle *E*, while a knurled-head screw *G*, for fine adjustment, forms the abutment for a dog fixed to the bed of the lathe which trips the feed automatically at any predetermined point. At *D* is the camshaft for operating the lead-screw nut. A counter-clockwise rotation of this shaft from the position shown closes the nut on the screw. Fixed to the camshaft is a cam *H* which, when the lead-screw nut is engaged, pushes the rod *F* to the right through the medium of lever *J* which is firmly secured to the rod. This action releases the trigger *C* and allows the drop-worm to fall out of engagement with the worm-gear, thus disengaging both the cross and longitudinal feeds before the lead-screw can be used. There are, however, several details in this type of design that are open to criticism, as will be pointed out in the following.

Objectionable Features of Design

Reference has already been made to the desirability of having all the feeds interlocked so that no two could possibly be in use simultaneously, but we have not yet considered whether the arrangement illustrated does actually meet all the requirements of a satisfactory interlocking device. From one point of view, it certainly does not. Suppose a machine were fitted with a device of this type, and the work required that the lead-screw be geared up, and running, the whole time, as would be the case on almost any job that involved both turning and threading.

Suppose now, that the tool had been set up for, say, facing a moderately deep shoulder and that the cut had nearly reached the body of the shaft. If at this time the handle on the camshaft that operates the lead-screw nut happened to be accidentally depressed, the cross-feed would be disengaged, but the lead-screw would come into action and there would be the possibility of a smash-up. There are also similar possibilities with the longitudinal feed and the lead-screw, though in this case the damage would probably not be quite so extensive.

The trouble is due to the fact that the feeds are not really interlocked, because this term means, if it means anything, that when one feed is engaged it is impossible to engage another; in any case it does not mean that the accidental engagement of one particular feed merely disengages the one that is in use, as in the type shown in Fig. 5. If this illustration is carefully examined, it will be seen that the portion of the rod *F* that is cut away at *K* to form the trigger is much wider than it need be. If the width were reduced and the left-hand side were bevelled as at *L* to match the back of the trigger piece, the whole principle of the device would be changed, and it would become, in fact as in name, an interlock, provided cam *H* and lever *J* were made of such a shape that the former could not be made to impart any movement to the latter. To meet these requirements, cam *D* and lever *H* should be designed as shown at *X*.

When the trigger is engaged with the rod, that is, when the worm is in mesh, the lead-screw nut cannot be closed, because lever *X* is held up by the cam, so, obviously, it is not possible to engage the nut when the worm and gear

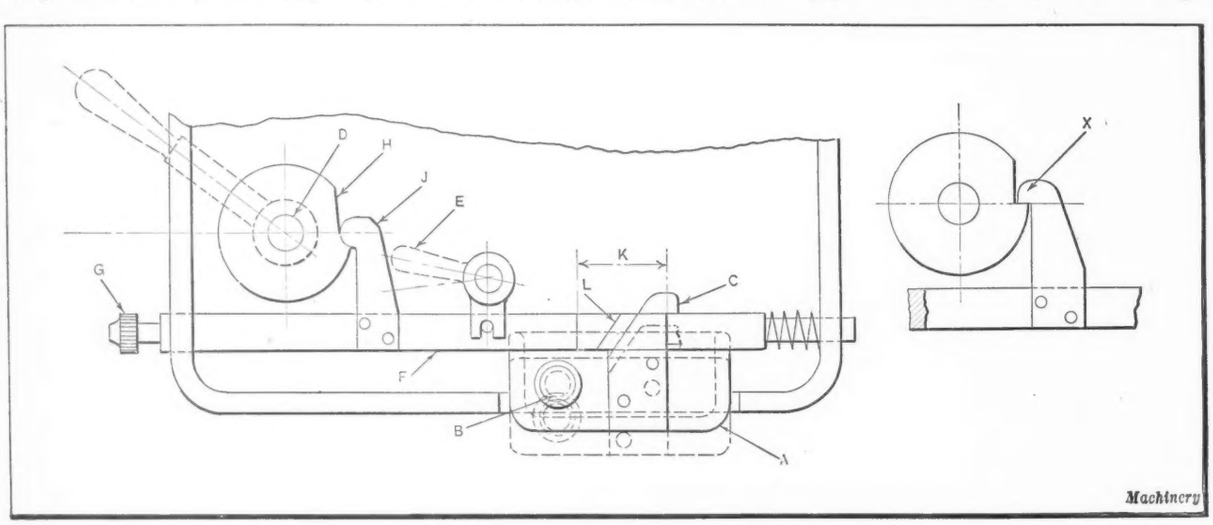

Fig. 5. Interlocking Device for Lathe Apron

are in mesh. Further, when the nut is engaged, the beveled face *L* prevents the engagement of the worm, as it interferes with the back side of the trigger when the rod *F* is positively prevented from movement toward the left. This simple alteration has converted an indifferent and imperfectly operating device into one that is theoretically and logically correct.

Effective Design of Interlocking Device

Fig. 6 shows another type of lathe apron in which all three feeds are genuinely interlocked to prevent conflicting engagement. In this design there is no drop-worm, the actual starting and stopping of the feeds being effected by a hand friction knob *A*, which couples gear *B* to the worm-gear *C*. At *D* is the rack pinion on which is keyed the large gear *E*, while at *G* is the cross-feed screw pinion which permanently engages with an intermediate gear *H*. Approximately midway between the intermediate gear *H* and the rack gear *E* is an eccentric shaft *J* carrying a gear *F* and a pinion *Y*. The eccentric shaft is controlled by a small lever *K*, which swings into three positions—the one shown, one to the right, and another to the left. In the position shown, the feed gears are entirely disconnected; if the lever is swung over to the right, pinion *Y* engages gear *E*, and gear *F* engages friction gear *B*. If swung in the opposite direction—to the left—the eccentric shaft gear *F* connects the intermediate gear *H* to gear *B*.

In the first case the longitudinal feed gears are engaged, while in the latter case the cross-feed gears are connected. Lever *K* is used only for engaging the required feed gears; that is to say, it does not actually start or stop the feed, this being done by the hand friction knob *A*. It is obvious that up to this stage the mechanism is perfectly interlocked, because when lever *K* is swung over, either to the right or to the left, only the particular feed represented by the given location of the lever can be engaged, the other being totally inoperative—that is, of course, as an automatic feed.

Since the lever cannot be in two positions at once, only one feed can be engaged at a time, the change from longitudinal to cross, or vice versa, necessitating, first, the disconnection of the feed by the hand-knob; second, the correct placing of the lever for the feed required; and third, the actual starting up of the feed by the hand-knob. So far as the cross and longitudinal feeds are concerned, then, we may assume that fairly complete interlocking is secured. However, there still remains the screw-cutting mechanism.

The lead-screw nut is operated by a camshaft *L*, and on this shaft is a collar *M* in which is cut a V-shaped groove. On the inside of the apron casting is a rectangular groove running from camshaft *L* to the eccentric shaft *J*, and fitting into the groove is a plunger *N* which is pressed always in the direction of the camshaft by a spring *O*. The lower or left-hand end of the plunger is pointed to fit into the V-shaped groove in collar *M* so that, in effect, the plunger acts on the camshaft as a snap plunger, thus reducing the risk of its being moved by vibration. At the opposite end, the plunger is narrowed down so as to enter a cross-groove *P*, cut in the boss of lever *K*. When the lever is in the position shown (the feed-gears being out of mesh), the camshaft handle *R* can be depressed and the nut connected with the lead-screw. The plunger *N*, meanwhile, is pushed to the right into the groove *P* in lever *K*, thus effectually locking the latter in the central position.

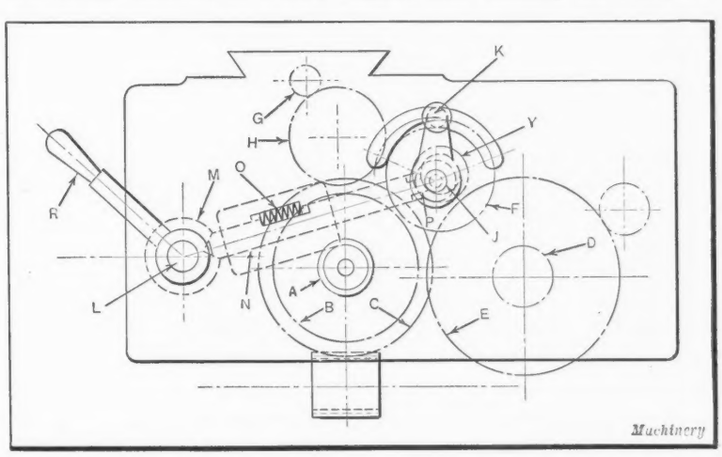

Fig. 6. Lathe Apron with All Feeds Interlocking

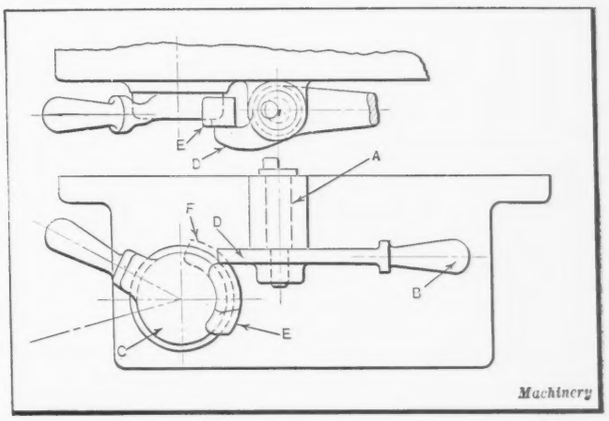

Fig. 7. Simple Interlocking Device

Suppose, now, that the lever *K* had been moved to either the cross or longitudinal feed position. The groove *P* in the boss on the lever would not then be in alignment with the plunger, so the latter could not move toward the right. This being the case, the nut-operating handle *R* could not be depressed, as it would be locked by the V-point of the plunger. Thus, only when the lever *K* is in the central or out-of-gear position can the lead-screw nut be engaged, and on the other hand, only when the lead-screw nut is disengaged can the feed-lever be moved, all three feeds being by this simple means, interconnected so that no two can possibly be in simultaneous engagement.

An Inexpensive Interlocking Mechanism

An example of effective design combined with low production costs is shown in Fig. 7, the interesting feature of this particular arrangement being that a perfect form of interlock is provided without the introduction of a single extra part. The device is fitted to a lathe apron and is of the type that applies only to the sliding and screw-cutting feeds, the cross-feed not being interlocked in any way. The eccentric shaft *A* operates a sliding clutch which engages the longitudinal feed when handle *B* is correctly manipulated. When the handle is pulled outward, the clutch is engaged and the feed started. At *C* is the cam-plate which controls the lead-screw nut; in the position shown the nut is disengaged from the lead-screw.

On the right-hand side of the cam-plate is cast a projection *E*, while on the boss of handle *B* is a lug *D*, the lower side of which is roughly located at the same height as the upper end of the cam-plate projection *E* when the lead-screw nut is disengaged. If the handle *B* is pulled outward to engage the feed, lug *D* moves over the end of projection *E* and prevents the cam-plate from being rotated to engage the nut. On the other hand, should the nut be first engaged, projection *E* moves upward into the position shown by the dotted lines at *F* and prevents the engagement of the feed by interfering with lug *D* on the hand-lever. So far as it goes, the design is perfectly effective and a good example of simplicity and cheapness, though, of course, it is rather lacking in completeness in so far as it does not also interlock the cross-feed.

Interlocking Device for a Back-shaft Type of Lathe

Fig. 8 shows still another example of a feed interlocking device as applied to the saddle of a

back-shaft type of lathe. Ordinarily, in the old style of back-shaft lathe, the three feeds, cross, longitudinal, and screw-cutting, are almost always entirely disconnected, so there is nothing to prevent all three being simultaneously engaged. To overcome the risk from this possibility, the arrangement illustrated in Fig. 8 was patented some years ago by an English firm. At the back of the saddle are two gears *A* and *B*, the former mounted on the cross-feed screw and the latter on the feed-shaft for the longitudinal feed. Gear *B* is driven from a worm *C* which is keyed to the back-shaft and free to slide on it, and both gears *A* and *B* run loosely on their shafts and are provided with clutch teeth on their front faces, which are engaged by clutches *D* and *E*, which are feathered to the cross-feed screw and the feed-shaft, respectively. Both clutches are operated by a single lever *F* through a small handle *H* and rack and pinion *G* and *J*.

When lever *H* is pushed toward the rear, clutch *D* is engaged with gear *A*, the other clutch *E* being meanwhile moved further away from its mating gear *B*. If the handle *H* is pulled toward the front, clutch *E* is moved into engagement, thus starting up the longitudinal feed. When the handle is vertical or in the mid-position, both clutches are out of engagement, and the cross and longitudinal feeds are inoperative. Obviously, then, it is impossible for the two feeds to be engaged at the same time.

Referring now to the screw-cutting motion, the nut is engaged through the usual type of cam-plate *K* by depressing the handle, so that the two half-nuts are engaged with the lead-screw. Immediately above the cam-plate is a short length of round rod *L*, the lower end of which is pointed to fit into a conical depression in the periphery of the cam-plate. The upper end just touches the round rack *G* when rod *L* is in its lowest position. Corresponding with the neutral position of the two feed clutches is a hole in rack *G* opposite rod *L*. When handle *H* is in the mid-position, the cam-plate handle can be depressed, rod *L* meanwhile being slightly raised until its upper end enters the hole in rack *G*, thus preventing the latter (and with it the feed clutches) from being moved. When the cam-plate handle is in the upper position so that the half-nuts are disengaged from the lead-screw, either of the feed clutches can be engaged as required, but no matter which is engaged, the hole in rack *G* is moved out of line with rod *L*, so it is impossible for the rod to be raised, and consequently for the lead-screw nuts to be operated.

It will be seen, therefore, that only one of the feeds can be in operation at any given time, so that the engagement of any of the three feeds definitely locks the remaining two out of engagement. The arrangement is simple and very effective in use, though one might offer a slight criticism of the use of toothed clutches in this connection. When a cut is in progress, the friction of the clutch teeth and of the sliding key will offer quite a substantial resistance to disengagement, and since the same handle operates both clutches, there would seem to be some possibility of one feed being accidentally engaged by the effort to disengage the other while under a heavy cut. However, it should be quite a simple matter to provide some form of stop for handle *H* which would prevent it from being moved in the opposite direction to the one required. This would minimize the risk of accidental breakage.

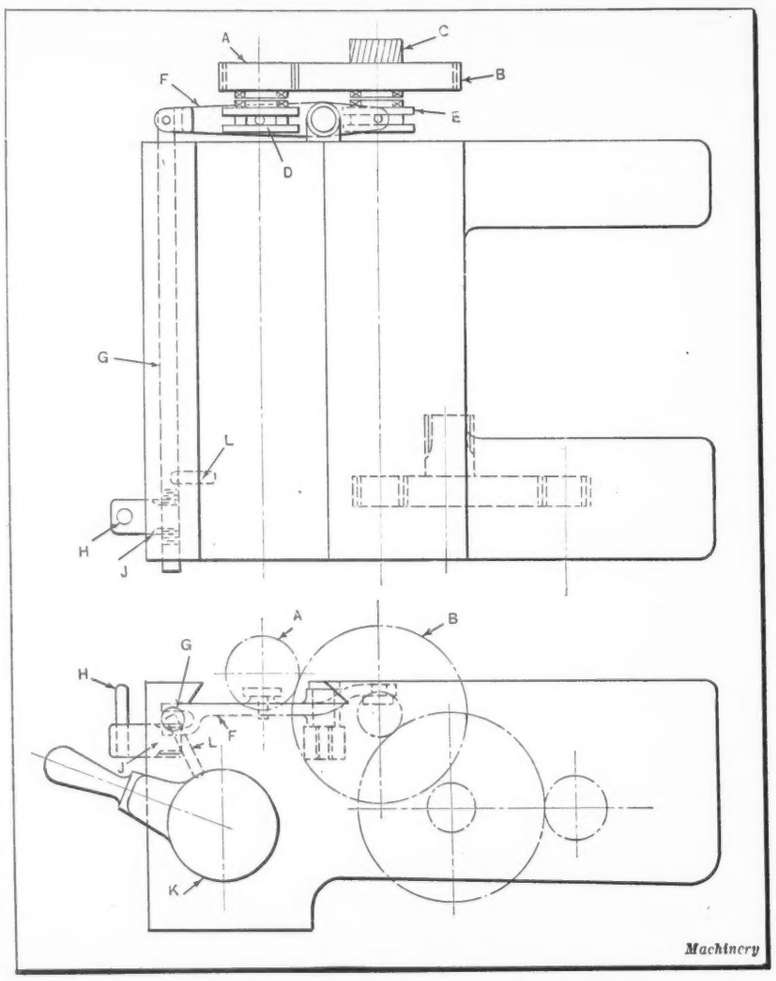

Fig. 8. Back-shaft Type of Lathe Saddle with All Feeds Interlocking

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Contrary to general belief, the largest number of accidents are not met with in industrial work. Shops and factories are not the place where the greatest number of people meet with either fatal or less serious accidents. In an article in *Safety Engineering*, W. W. Rodgers of the Westinghouse Electric & Mfg. Co. states that while 80,000 people are killed by accidents annually in the United States, 50,000 of these deaths are accounted for by accidental falls, automobile accidents, fires, railroad accidents and drownings. The remainder of the fatal accidents are due to gas, firearms, street car accidents, injuries by vehicles other than trains and automobiles, and finally, accidents from machinery and mining operations. These statistics indicate that the industries are responsible for but a very small number of the toll of life due to accidents.

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DEMAND FOR MACHINE TOOLS IN CHINA

In a review of the industrial and economic situation in China, published by the Department of Overseas Trade of the British Government, it is stated that there is a fairly steady demand for machine tools, especially for lathes of practically all types, from bench lathes to heavy wheel-turning lathes required for turning locomotive driving wheels 6 feet in diameter. Punching and shearing machines are also in demand, as well as radial drilling machines. Woodworking machines of practically all types can be sold in China. There is a rapid increase in the number of factories, most of which require machine shops for repair work. The railways are also beginning to appreciate the necessity of up-to-date machine shop equipment. In the past, German competition in this field has been quite active, but of late this has become comparatively insignificant.

Historical Notes on Gear Teeth

Evolution of Gear Teeth from Crude Beginnings and Early Equipment for Cutting

By LUTHER D. BURLINGAME, Brown & Sharpe Mfg. Co., Providence, R. I.

IN seeking an answer to the question, "When and by whom were gear teeth invented?", there is more involved than merely a question of the invention of transmitting motion by gear teeth. Like most other great mechanical developments, there has been a gradual evolution from crude beginnings to the present advanced art of producing gear teeth. The invention of geared wheels dates far back to the early days of European civilization. They were known to Archimedes, the celebrated mechanician, who lived 287-212 B.C., according to Ctesibius of Alexandria in his "History of Mathematics." It is even claimed that in one of Aristotle's works on mechanics a reference indicates that he knew of toothed wheels as early as 350 B.C.

Ctesibius first applied gears to the clepsydrae (water clocks) about 150 B.C. One design had a rack and pinion for revolving the hand on the dial. Another was equipped with spur and bevel gears, and the falling tears of a weeping cherub marked the time by filling a reservoir containing a float which raised a second cherub until a pointer, registering the hours as they passed, reached the top of a cylinder, having indicated the twenty-four hours of the day. The water then siphoned through a pipe to a pocket in a bucket wheel below, and by its weight, acting through the gearing, revolved the cylinder a space representing one day, there being registering lines for 366 days on the cylinder. The gearing used from bucket wheel to cylinder consisted of a bevel pinion of 6 teeth, a bevel gear of 60 teeth, and driving and driven spur gears having 10 and 61 teeth, respectively. The bucket wheel was provided with six pockets so that one-sixth revolution of the wheel caused the cylinder to make 1/366 of a turn.

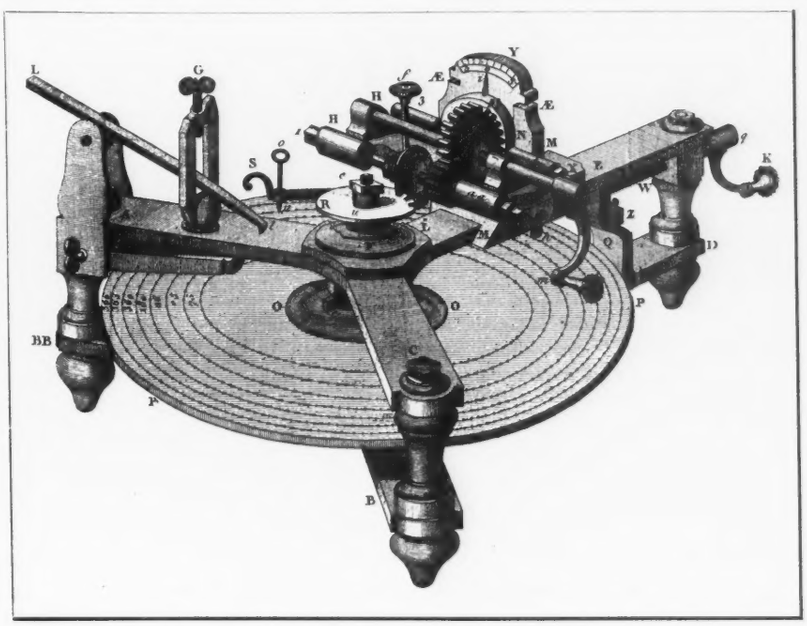


Fig. 1. Hand-operated Gear-cutting Machine built in 1802

The knowledge and use of toothed wheels by the Romans early in the Christian era is indicated by the fact that they are shown sculptured on the Column of Trajan in Rome. Leonardo da Vinci, that myriad-minded genius, showed an appreciation of the use of gearing, many applications of it in connection with mechanisms devised for widely varying purposes being found in the sketches that form a part of his "Codice Atlantico" a copy of which voluminous work is in the New York Public Library. This work illustrates the use of worm-gearing, and suggests a choice of two forms of teeth, one of the buttress type and the other in shape much like present-day practice. Leonardo's work was contemporary with Columbus and his voyages of discovery. We do not know that Leonardo or any of his predecessors analyzed the problem of securing theoretically correct shapes of teeth to insure uniform motion.

Epicycloidal Form of Teeth

The earliest evidence we have of an investigation of the problem of uniform motion for toothed gearing and the successful solution of that problem, dates from the time of Olaf Roemer, the celebrated Danish astronomer, who, in the year 1674, proposed the epicycloidal form to obtain uniform motion in trains of gearing. The need for accurate gearing in the manufacture of clocks and watches increased the importance of the solution of this problem. Many years later—in 1766—Charles E. L. Camus, a French genius, who when but twelve years of age had made such progress in science that he gave lectures on mathematics in Paris, produced a work, "Cours de Mathematique," a part of which, dealing with gearing, had been pre-

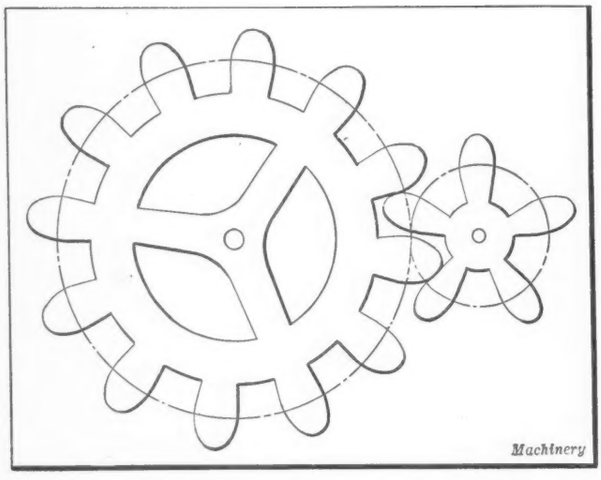


Fig. 2. Epicycloidal Teeth as shown by Camus in the Eighteenth Century

pared in 1752 as an essay on the teeth of gear wheels. This fully describes the epicycloidal curve in such a way as to make it for the first time available to some extent for application by mechanics, and points out its advantages as applied to gearing. Camus deals only with the epicycloidal form of tooth, and emphasizes its application to clock and watch work. He treats first of the principles involved in order to secure uniform motion, and shows applications of the use of lantern pinions where the pinion has cylindrical "rungs" engaging a mating wheel with epicycloidal teeth. He then treats of gears in which both the pinion and mating gear have epicycloidal teeth. An illustration from his work showing a five-toothed pinion engaging a twelve-toothed gear, is reproduced in Fig. 2.

Camus discusses the action of the teeth when engaging before and after passing the line of centers, and points out that the best action results when the engagement takes place after the working face of the driving tooth has passed the line of centers. He then demonstrates the method of finding the least number of teeth in a pinion which can have continuous action when the driving is done after passing the line of centers.

The view at the left in Fig. 3 is a reproduction of the diagram used by Camus to show that 10 teeth on the pinion can engage 72 teeth on the driving gear and have receding action only. This he himself criticises as making the teeth of the pinion rather thinner than desirable, and shows an illustration (see view at right) that he considers the practical solution where, as a compromise, a small portion of the action is during approach, so as to allow for thicker teeth in the pinion. Camus' treatise deals also with bevel gears having teeth of the epicyclic form, and concludes with a chapter on calculating trains of gearing.

Interchangeable Gearing

Even up to the year 1832 a method of producing interchangeable gearing does not seem to have been in use, as Reid in his work "Clock and Watch Making" of that date says, referring to laying out the teeth of gears: "The size of pinions of 6, for example, or any other, differ according as they make a greater or less number of turns with regard to the wheel. Thus a pinion of 6 which is driven by a wheel of 60 is a different size from the pinion of 6 which is driven by a wheel of 30."

The epicycloidal form of tooth as laid out by Reid's method is shown in Fig. 4.

It would seem that Robert Willis, professor in the University of Cambridge, was the first to make a practical application of this curve in such a manner as to provide for a series of gears running in sets. Willis gives credit to Camus for conceiving the idea of interchangeable gears in a set, but claims for himself its first application. About the time of Willis, Edward Sang, professor of mechanical philosophy in the Imperial School at Constantinople, presented a paper before the Royal Scottish Society of Arts in which he pointed out the need of a study of the proper form of teeth for sets of wheels. He says, in effect, that it is "so as to compound the outline of the wheel so that if a multitude of wheels engage, the form will be such as to suit each pair, so that gears may be grouped together in systems, and produce complete interchangeability among wheels of one system." His demonstrations are abstruse and highly technical, and apparently had little influence on mechanical development. A great contribution that Willis made was to clear away the cobwebs and make the subject plain. In suggesting the practical means by which interchangeable gears could be produced, he states the difficulty and his proposed remedy as follows:

"Teeth whose forms are derived from the previous solutions . . . are subject to this inconvenience; a wheel of a given pitch and number of teeth, for example 40, if it be made to work correctly with a wheel of 50 teeth, will not suit a wheel of any other number, as 100. This is obvious, for the diameter of the describing circle by which the epicycloid is traced must be made equal to the radius of the pitch circle of the wheel with which the teeth are to work, and will therefore be, in this example, twice as large in the second case as in the first, producing different epicycloids."

He goes on to show how serious a limitation this proves in practical work and then says: "If for a set of wheels of the same pitch a *constant describing circle* be taken and employed to trace those portions of the teeth which project beyond each pitch line by rolling on the exterior circumference, and those which lie within it by rolling on its interior circumference, then any two wheels of this set will work correctly together." Fig. 5 shows Willis' diagram illustrating his method of making interchangeable sets of epicycloidal gears.

As a further development of the practical application of these principles to wheels, Oscar J. Beale, then employed by the Brown & Sharpe Mfg. Co., brought out in 1884, what he called "Beale's Blue Book on Gear Wheels" (Fig. 6). This book was so named because it was made up of blueprints (then just coming into use). It brought still further within the range of ordinary mechanics the principles and methods by which the teeth of gear wheels could be produced in a machine shop. This book, which at the time became very popular with mechanics because of its directness of method and simple wording, has since been enlarged and has grown into the "Practical Treatise on Gearing" published for many years by the company referred to.

Mr. Beale made a life study of the subject of gearing, and realizing the need of mechanical means for producing theoretically correct epicycloidal teeth, he designed and built the odontograph machine shown in Fig. 7. This machine has since been presented by the Brown & Sharpe

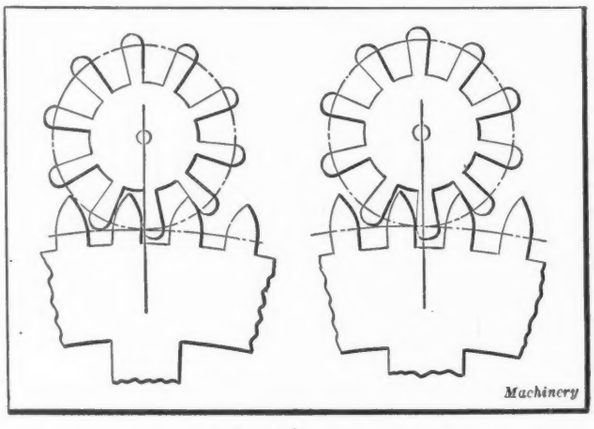


Fig. 3. Diagrams of Epicycloidal Teeth used by Camus to show Limiting Numbers of Teeth

Mfg. Co. to Columbia University, where it is being preserved for its historical interest. Mr. Beale said regarding it:

"The principle of this machine consists in the employment of rolling, or describing circles, to describe the tooth outlines, the same as shown in technical books treating on the teeth of gear wheels. Steel bands prevent any slipping of the circles. A radial bar pantograph enables different pitches to be described. An ingenious shifting device enables first the outside rolling circle to control the graver, and then the device shifts over, after it reaches the pitch line, and the inside circle controls the graver, thus describing the outline of one side of a double-curve epicycloidal gear tooth. After describing one side of a sufficient number of gear teeth, the shifting device is reversed, which enables the other side to be described. Different base circles are employed, corresponding to the required number of teeth in the gear to be described."

While this first machine had means for describing the curves, a later and more highly organized machine, built under Mr. Beale's supervision and known as the "odontom engine" (Fig. 8), had in addition an arrangement for milling the outline of epicycloidal teeth, cutting out original teeth in thin metal. This is the master machine for the epicycloidal gear cutters since made by the Brown & Sharpe Mfg. Co. It has been called "a beautiful illustration of a mechanical solution of a geometrical problem that is difficult in the machine shop." The Pratt & Whitney Co. also built an epicycloidal engine of quite a different design, which was first described and illustrated in 1880.

Involute Gears

At the time that the "odontom engine" was built, there was a feeling on the part of some people that epicycloidal gears would "win out" in the competition between the epicycloidal and involute forms of teeth; but the practical advantages of the involute have steadily crowded out the epicycloidal until at present the involute has, generally speaking, triumphed. While the involute tooth had been suggested as a theory by early scientists and mathematicians, it remained for Willis to present it in a practical form for use by the manufacturing public. Perhaps the earliest conception of the application of this form of teeth to gears was by Philippe de Lahire, a Frenchman, who considered it, in theory, equally suitable with the epicycloidal for tooth outlines. This was about 1695 and not long after Roemer had first demonstrated the epicycloidal form. The applicability of the involute had been further elucidated by Leonard Euler, a Swiss mathematician, born at Basel, 1707, who is credited by Willis with being the first to suggest it. Euler's studies on gear teeth can be found in his paper on the "Teeth of Gear Wheels" presented before the Academy

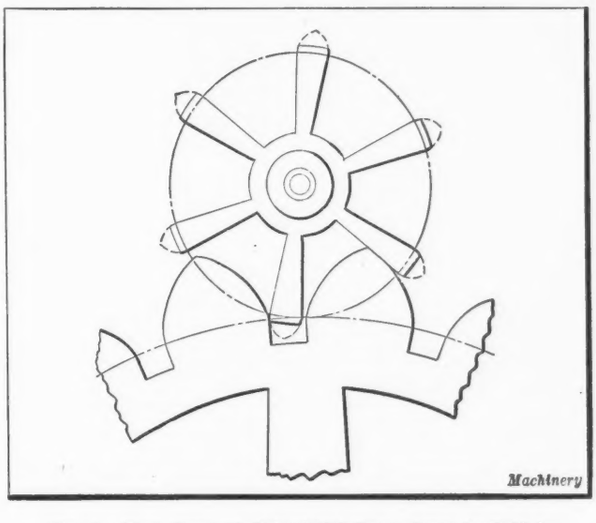


Fig. 4. Clock Gears of Epicycloidal Form shown by Reid in "Clock and Watch Making" (1832)

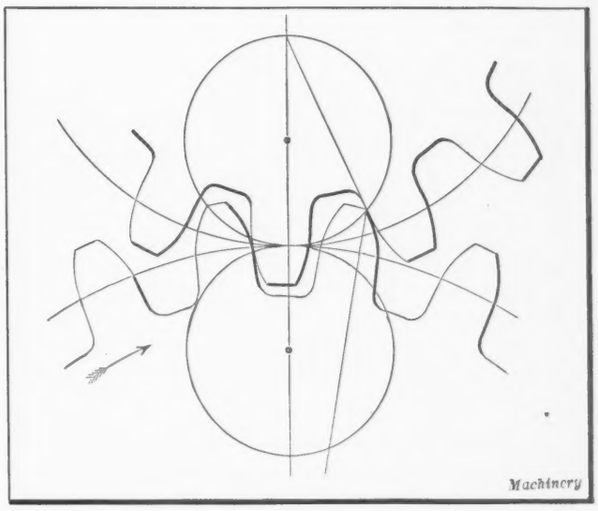


Fig. 5. Diagram by Willis showing an Interchangeable System of Epicycloidal Gearing (1837–1841)

of St. Petersburg about 1767, and published in the Transactions of that academy.

Prof. Joseph W. Roe in "English and American Tool Builders" says:

"Euler in 1760 and Kaestner in 1771 improved the method of applying the involute, and Camus, a French mathematician, did much to crystallize the modern principles of gearing. The two who had most influence were Camus and Robert Willis, whose name still survives in his odontograph and tables. All the later writers base their work on the latter's essay on 'The Teeth of Wheels' which appeared originally in the second volume of the Transactions of the Institution of Civil Engineers in 1837." This essay was republished in Willis' "Principles of Mechanism," first edition, 1841. A copy of this rare edition is in the possession of Henry D. Sharpe, and has this unique history. It was originally owned by Joseph R. Brown and contains extensive notes in his handwriting, showing that he made a careful study of it. After the second edition of Willis was issued, this copy came into the possession of Oscar J. Beale, who was then seriously taking up the study of gear teeth. Mr. Beale later transferred it to Ambrose Swasey, who, realizing its historic value to the company originally owning it, presented it in 1908 to Mr. Sharpe, with this comment regarding it:

"From the notations made in it in pencil by Mr. Brown I judge it was used by him as a text-book more especially in matters pertaining to gearing . . . I remember of meeting Mr. Brown but once and that was on one of his visits to the Pratt & Whitney Works. I remember that Mr. Pratt, in showing him about the shop, brought him to the gear-cutting department, of which I then had charge. Both of them being greatly interested in the problems relating to gear-cutting, had much to say of interest regarding the subject."

In estimating the importance of the contribution made by Willis, attention should be called to the fact that shortly before Willis, Hawkins, in the second edition of his translation of Camus, adds a rather lengthy appendix, which seems to be largely for the purpose of emphasizing the advantages of the involute as compared with the epicycloidal, and the author gives his reasons so clearly that they can be considered prophetic of what was to follow. He says:

"Since M. Camus has treated of no other curve than the epicycloidal, it would appear that he considered it to supersede all others for the figure of the teeth of wheels and pinions," but in critically examining the involute, the translator has discovered advantages which had before escaped his notice.

Hawkins mentions a number of authorities who, although having knowledge of the involute, have been inclined to

give the epicycloidal the supremacy, going on to say, however, that although originally prejudiced in favor of the epicycloid himself, he felt that the involute had such possibilities as to warrant further investigation. To satisfy himself regarding a criticism which had been made of the involute to the effect that it produced undue thrust upon the bearings, he made a series of experiments, the results of which he included in his appendix. In these experiments he revolved pairs of involute gears together and tested the tendency for the centers to thrust apart. He was greatly surprised to find that this thrust was nearly negligible, although tried under many varying and extreme conditions, and he came to the conclusion that the friction of the engaging teeth counteracted the tendency to crowd apart so as to produce almost a perfect balance.

Professor Roe in his work previously referred to says: "Hawkins seems the first to have grasped the practical advantages of the involute form of teeth . . . breaking away from Camus, the very authority he was translating, who seems to have controlled the thought of everyone else."

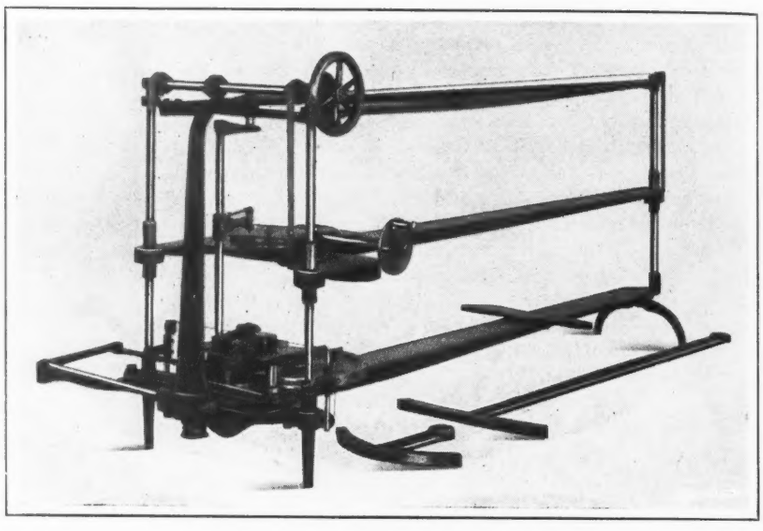


Fig. 7. Odontograph Machine for laying out Gear Teeth, made by O. J. Beale in 1876

Another part of Hawkins' Appendix is of special interest because it shows that no practical system of gearing had been established up to that time (1837) in Great Britain. After mentioning as users of gears fourteen of the leading engineers and manufacturers of mechanical and mathematical instruments in England, he goes on to quote from them as to their practice, in part as follows:

"We have no rule but the eye in the formation of the teeth of our wheels" . . . "We draw the tooth correctly on a large scale to assist the eye in judging of the figure of the small teeth" . . . "In Lancashire they make the teeth of watch-wheels of what is called the bay-leaf pattern; they are formed together by the eye of the workman; and they would stare at you for a simpleton to hear you talk about the epicycloidal curve" . . . "The astronomical instrument makers hold the bay-leaf pattern to be too pointed a form for smooth action; they make the end of the tooth more rounding."

Even taking into consideration the disclosures of Hawkins, Willis evidently had a much clearer appreciation of the practical possibilities of the involute than any of his contemporaries. He particularly points out the advantage of this curve where there is a variation of center distance because of its being the only form where the ratio of angular motion of the two curves will under such conditions remain unaltered and therefore continue to give uniform motion. He also points out its advantage in making interchangeable sets of gears.

A great service that Willis rendered in making the involute popular was by devising the Willis odontograph for laying out the teeth (Fig. 9). This illustration also indicates the form of involute proposed by him, which is essentially the same as that in use today not only as to tooth curvature but also as to height and pressure angle. While the selection of a pressure angle was arbitrary, 14½ degrees was recommended by Willis as giving the best results, one of the reasons for selecting this angle being that the sine of 14½ degrees is practically ¼, making it convenient in calculation. Another reason for using this angle is that it coincides closely with the pressure angle resulting from the usual construction of epicycloidal gear teeth. Further, it is the same as the angle used for worm threads, so that the straight-sided rack of the involute system corresponds in angle, as well as in other tooth proportions, with the worm thread.

A champion of the involute as against the epicycloidal at a time when the contest between these two systems was at its height and hung in the balance was George B. Grant who regarded the directness of action and reduction of bearing thrust, claimed for epicycloidal gears as largely theoretical, whereas the involute or single curve has the practical advantage of permitting "slight but inevitable inaccuracies in shape and in mounting," and will cause comparatively little trouble due to slight variation in making or from wear, of the center distance, shaft alignment, or in the radial direction of the teeth.

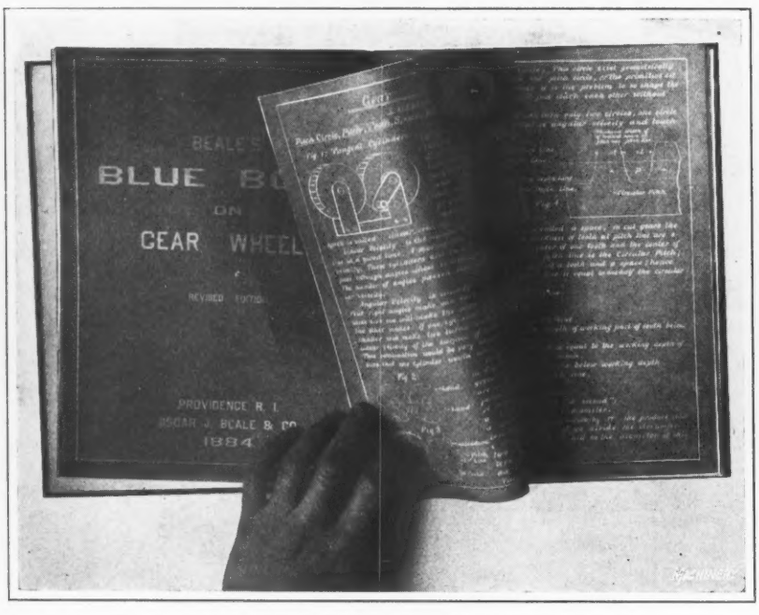


Fig. 6. "Beale's Blue Book on Gear Wheels" brought out in 1884

Rotary Cutters for Gear Teeth

The difficulty of making cutters for cutting gear teeth was a great stumbling block in the way of producing good gears. The earliest gear-cutter of which the writer has knowledge (see Fig. 10) was made by the famous French mechanic, Jacques de Vaucanson, some time prior to his death in 1782, although it is possible that Leonardo da Vinci may have conceived the idea of a gear-cutter nearly 300 years earlier, as one

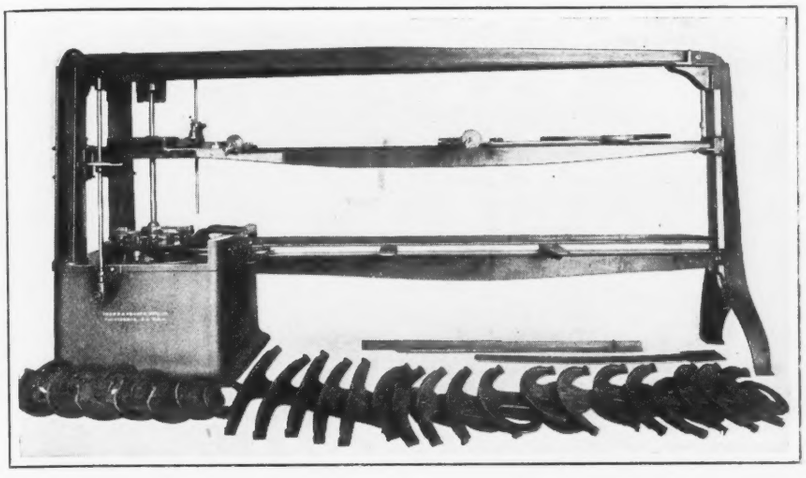


Fig. 8. Odontom Engine designed by O. J. Beale for laying out and cutting Gear Teeth

of his sketches evidently represents his conception of a method of cutting the teeth of the segment by means of a rotary cutter or possibly a hob.

The ingenious workman Vaucanson was born at Grenoble in 1708 and was the inventor and maker of many wonderful automatons. The gear-cutter of his make (Fig. 10) was presented to Lucian Sharpe by his friend F. G. Kreutzberger, a director of the French Arsenal of Peuteaux. It was apparently made by chipping the fine teeth with hammer and chisel before hardening. Its appearance is such that it might be considered a rotary file. Even up to the middle of the last century no better way had been found for producing gear teeth than by the use of such crudely made cutters. A cutter of that period made by the Phoenix Iron Works of Hartford, Conn., had teeth chipped by hand; when the teeth became dull, they were annealed and the faces peened, or upset with a drift. The cutter was then driven on a mandrel and while running backward was turned to fit a templet, after which clearance was filed and the cutter again hardened.

It was not until Joseph R. Brown invented the formed cutter in 1864 that the use of accurately cut gearing came into its own, and it is difficult to realize at this time, when the use of such gearing is an everyday affair and when the industrial arts have come to depend so fully on it, the great importance of this simple invention, the formed cutter, to mechanical progress. In the Patent Office specifications of this epoch-making improvement is found this clear statement of the then existing conditions and the nature of Mr. Brown's improvement:

"Ordinarily the teeth or blades of the cutter are filed up to a cutting edge in quite an imperfect manner, and as the requisite clearance in such teeth or blades is considerable, any subsequent sharpening of the teeth reduces their cutting contour so materially as to alter both the size and form of the teeth which they are intended to cut, and thus renders the cutter useless. My improvement, to overcome this difficulty, consists in constructing the teeth or blades in the form of segments or curvilinear sections that are mechanically accurate in outline, and of equal size and contour throughout their entire length, each of which has a sufficient circumferential inclination with respect to the revolving circumference of the cutter to produce the proper degree of clearance so that the tooth may be sharpened by grinding away its face until the strength of the tooth is permanently impaired, and always present the same cutting contour, each new face and cutting edge produced by grinding being a fresh radial section of an equi-form tooth throughout its whole length."

Professor Roe says of the formed cutter: "It came as one of the important elements in the system of interchangeable involute gears, introduced by Brown & Sharpe, based on the principles of Professor Willis. While they used both the involute and cycloidal systems they threw the weight of their influence toward the former and were a strong factor in the general adoption of the involute form for cut gearing, as well as for the use of diametral pitch."

Sets of Cutters

Practical gear-cutting was accomplished by making the cutters in sets for each pitch. In the case of epicycloidal cutters, experience showed that a set of twenty-four cutters was necessary to cut all gears from a 12-tooth pinion to a rack with sufficient accuracy as to shape so that they would run together properly. A decided advantage of the involute system was found to be that only eight cutters were required in a set to produce equally satisfactory results, and that by introducing half cutters, making fifteen, in all, in a set, a very high degree of accuracy could be obtained. Another advantage of the involute cutter is that there is less tendency to "drag" than with the epicycloidal, because of the greater inclination of the sides of the involute teeth.

The idea of making cutters in sets can be traced back to Willis, where he gives tables suggesting the number of teeth for which cutters should be provided, his suggestions having been generally followed in modern practice. Willis also suggested a convenient height of tooth, making the addendum equal to 1 divided by the diametral pitch. The arguments at that time for determining the height of the addendum were its convenient relation to the pitch such as made it easy to determine the outside diameter of the gear in calculations by adding 2 to the number of teeth of the gear, and a length such as to give continuous contact and the greatest number of teeth in contact in a system having the lowest possible number of teeth in the smallest pinion of the set, 12 teeth being generally adopted as the minimum. Since that time there has been an extended discussion as to the question of pressure angle and the height of the tooth, many special cases being brought forward to show an advantage in using a greater pressure angle and shorter tooth than proposed by Willis, while in other cases a smaller pressure angle and longer tooth have been found desirable. The average between these extremes has continued, however, as the standard for the majority of gearing.

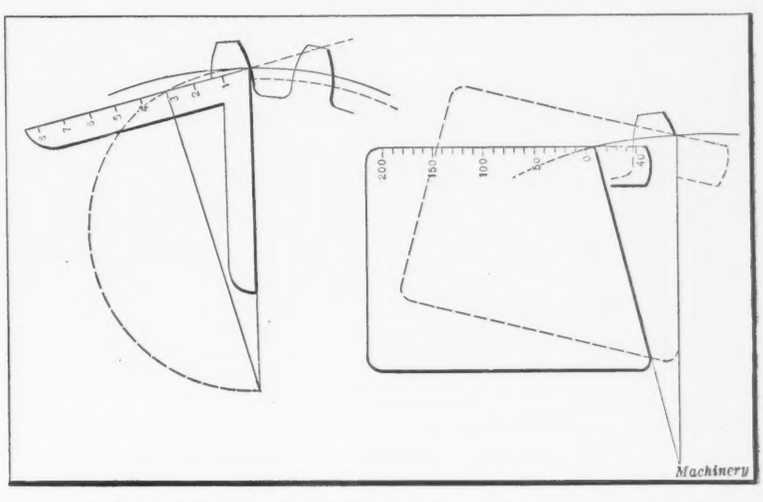


Fig. 9. Willis Odontograph as used for laying out Involute Gear Teeth (1837–1841)

Diametral Pitch

The convenient method of figuring gearing by diametral pitch originated in England, according to Frederick A. Halsey, in "Methods of Machine Shop Work." He says that the diametral pitch system, originated by Bodmer and used by some in England, was introduced into general practice by the Brown & Sharpe Mfg. Co., through their production of diametral pitch cutters as an article of manufacture. John G. Bodmer was born in Zurich, Switzerland, in 1786. He first went to England in 1816, later establishing a factory at Manchester. Because of the system of diametral pitch for gears first having been used by him in his shop they were called "Manchester pitch gears" in the early days. The involute, specified by diametral pitch, has been an important step toward gear standardization, as this system has largely supplanted all other systems and has to a great extent been standardized as to the proportions of teeth.

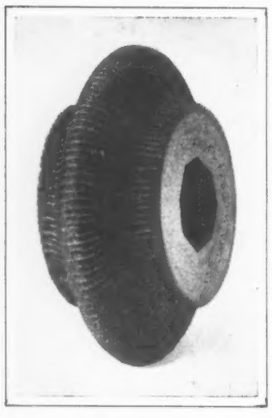


Fig. 10. Gear-cutter with Hand-chipped Teeth made Some Time before 1782

Machines for Cutting Gears

While this article deals primarily with the gear teeth themselves and their shape, a word regarding early gear-cutting methods, additional to what has already been discussed under the head of cutters, will serve to show the great progress that a little more than a century has brought about. An early gear-cutting machine, such as was used at the beginning of the nineteenth century, is shown in the French work "Berthoud Histoire de la Measure du Temps," published in Paris in 1802. This machine (Fig. 1) is hand-operated. The two volumes of the above work are preserved in the historical library of the Brown & Sharpe Mfg. Co., because of having been originally purchased in 1850 by Lucian Sharpe when an apprentice to Joseph R. Brown. An entry on the fly-leaf in Mr. Sharpe's own handwriting notes that the cost of the two volumes was $13.56; an interesting point is that he, an apprentice, was studying works printed in French, on watch and clock making and on gearing, and was using so material a part of his apprentice wages to procure such books.

In 1855 Joseph R. Brown built a power-driven precision gear-cutting machine. After his invention in 1861 of the universal milling machine with its indexing and spiral head, spur, bevel, and spiral gears could be produced on this machine, and its use for these purposes was greatly stimulated when Mr. Brown added the formed cutter to the list of his inventions. A few years later the prototypes of modern automatic gear-cutting machines were brought out, and since that time gear planing, hobbing, and rolling have been added to the methods for producing gearing, involving such problems as producing curved tooth spur and bevel gears and bringing into prominence the names of Bilgram, Gleason, Fellows, Eberhardt, and many others. Another refinement of modern times is the grinding of gear teeth and even the grinding of curved teeth is having attention in the effort to attain a still greater degree of accuracy and quiet running.

What Gearing has Meant to the World

It is difficult to conceive of a world today without gearing. Its elimination would "throw a monkey wrench into the gears of progress." Once, many years ago, an inventor placed an order for a special machine of some complication. He had a prejudice against toothed gearing, and one stipulation was that in designing his machine none should be used. It taxed the ingenuity of the designers to find ways to accomplish the desired results without gearing, and even then no way was found except by greatly added complication and expense. In many other instances, construction without the use of gears would be impossible. The automobile of today, to mention one prominent example, could not exist without them, and modern machine tools are absolutely dependent on their use. This might be said of the whole field of special machinery on which the industries of the world depend.

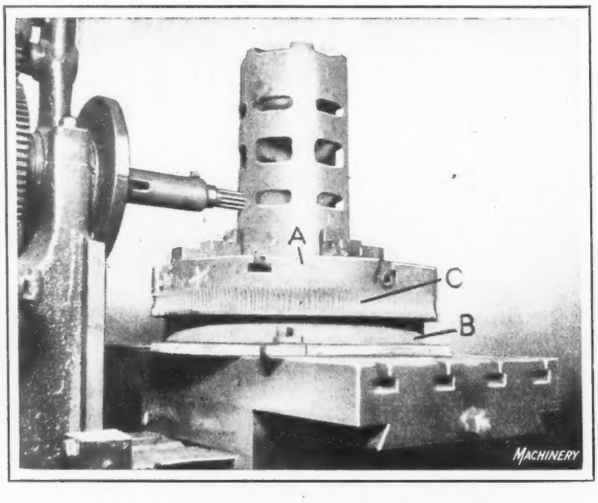
Without doubt the early studies of the scientists and professors, in their efforts to produce theoretically correct gear teeth, were scoffed at in their day and their work was looked on by "practical men" as visionary and a waste of time. Some of them, however, had the vision and persistence of true prophets, and we owe a debt of gratitude to them for their pioneer work. One form of appreciation which this generation, now profiting by their labors, can show is to preserve and keep fresh in mind their names and the record of their accomplishments.

* * *

PORT-MILLING DEVICE FOR PISTON-VALVE BUSHING

By H. H. HENSON

The milling attachment shown in the accompanying illustration was designed for use in machining the ports in locomotive piston-valve bushings. The attachment can be used on a milling machine or on a horizontal boring machine, as shown in the illustration. The work-holding chuck *A*, which was made from an old discarded lathe chuck, is fastened to base *B* by a stud that passes through the center of the base. Rotation of chuck *A* about this stud is obtained by means of gearing and a shaft equipped with a universal joint that drives a worm meshing with the teeth cut in the periphery of the chuck at *C*. The feeding mechanism is clamped to the table of the horizontal boring mill, and can be quickly



Set-up for milling Ports in Piston-valve Bushing

removed when the machine is required for other work. The time required to complete the milling operation on a valve bushing like the one shown in the illustration is from thirty to forty minutes.

* * *

The iron and steel and machine shop industries of India are developing quite rapidly, and several hundred thousand workers are now employed in Indian machine shops. Of these 19,000 work in arms and ammunition factories; 26,000 in iron and steel works; 26,000 in shipbuilding yards; 153,000 in railway shops; and 75,000 in other machine shops. In a country where approximately 300,000 men are employed in shops using machine tools, there must be a considerable market for shop equipment.

DESIGN OF CAN DIES

By EDWARD J. RANTSCH
Master Mechanic, Metal Package Corporation, Brooklyn, N. Y.

The writer read with interest the article descriptive of the design and construction of can dies, which appeared on page 200 of November MACHINERY. Referring to the punch shown in Fig. 1 in that article, it appears to the writer that it would be rather difficult to obtain a good shrink fit of

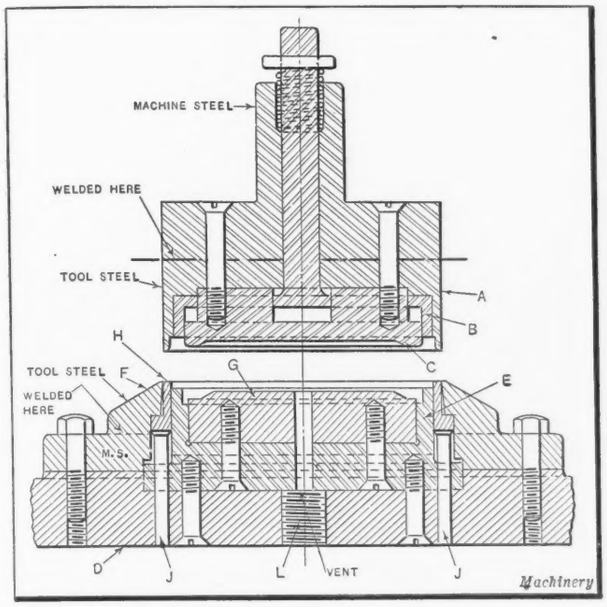


Fig. 4. Punch and Die designed for Use in the Production of Can Dies

ring *C* on body *A*, because of the comparatively thin walls of the ring. A ring with such thin walls is very easily expanded, and it has been the writer's experience that a shrink fit obtained under such conditions cannot be depended upon to withstand the hard usage to which such dies are generally subjected.

The writer might mention here that he has found it unnecessary to harden knock-outs, such as shown at *F*, if these parts are made from a tool-steel forging with the stem and body in one piece. Referring to the cut-edge die *G*, it will be evident that it is a rather difficult problem to drill and tap the holes for the flat-head screws, so that the parts will fit well after the hardening operation. If the cut-edge die *G* is turned to a snug fit for the recess in the cast-iron plate *M*, and the holes located, drilled, and tapped, it is probable that die *G* will be contracted or expanded to such an extent after hardening that it will not fit the recess. On the other hand, the holes cannot be drilled and tapped after hardening.

In Fig. 2 of the same article it will be noted that the punch is not provided with a knock-out. It is evident, however, that a knock-out is essential in a die of this type, as the pressure ring *A* would force the shell from the die so that it would be left in the punch on the up stroke of the press. The shell must be ejected when the press ram reaches the top of its stroke; it will then fall out of the punch and clear the die. If the shell lies on the die, it must be pushed out of the way before the press can be tripped again, thus interfering with the operation.

Referring to Fig. 3, it is evident that no means are provided for regulating the amount of pressure on the drawing ring. To the writer's mind this would be unsatisfactory, as die-setters find it necessary to adjust the pressure on the drawing ring at different times during the day in order to prevent the work from wrinkling or tearing, especially when the faces of the punch and the pressure ring have begun to show wear.

In the following is described the design of a die that is a decided improvement in some respects over the one referred to. The design described and shown in the illustrations in the present article has been employed for some time, and is still used in constructing new dies. As shown in Fig. 4, the punch consists of only three parts, the punch head *A*, the knock-out *B*, and the forming block *C*. The punch *A* is made from two pieces welded together, the shank being made from machine steel and the lower or cutting edge from tool steel. The welding together of these two forgings is, of course, a "blacksmith-machinist" job. It has been the writer's experience that such construction gives the best results and should be employed whenever possible. The forming block *C* is a one-piece tool-steel forging, and is not hardened. This part is also shown at the left-hand side of Fig. 6. The knock-out *B*, shown in the assembly view, Fig. 4, and at the right-hand side of Fig. 6, is also a one-piece tool-steel forging, not hardened.

Referring to Fig. 4, the cast-iron bolster plate *D* is recessed to fit the plug *E*, which is hardened and finished by grinding. As shown in Fig. 5, plug *E* is made of two pieces welded together. This makes it possible to drill and tap the holes for the assembling screws after the hardening operation has been performed. It will be noted in Fig. 4 that the shoulder of plug *E* projects about ⅛ inch above the cast-iron bolster *D*, so that the cut-edge die *F* can be centered on this shoulder, with a good tight fit. In plug *E* is fitted the insert *G*, which is another tool-steel forging. The pressure ring *H* is also a tool-steel forging, and is supported by the pressure pins *J*. The cut-edge die *F* is a two-piece forging, and is held on the bolster by four 7/16-inch hexagonal cap-screws. This permits the removal of the cut-edge die without taking the complete die from the press.

The view at the right-hand side of Fig. 5 shows the regulation pressure pad used in combination drawing dies. It consists of a rubber pad, of suitable size, held between two

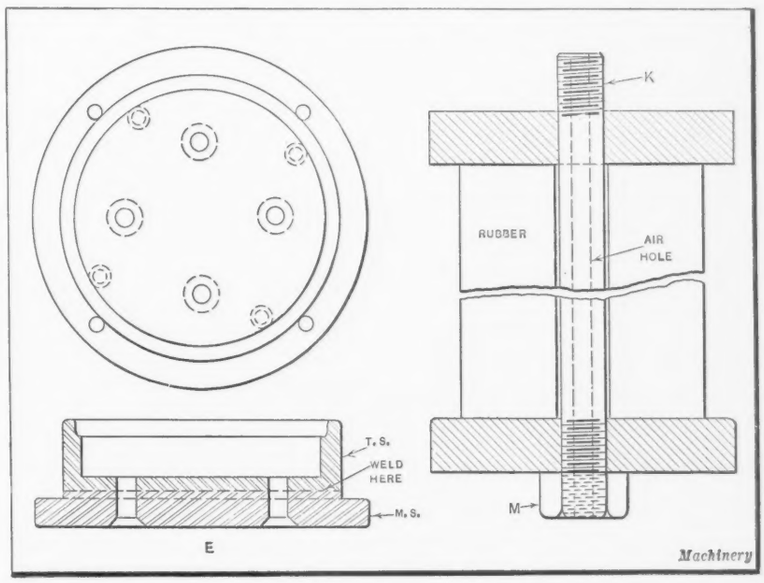


Fig. 5. Insert E used in Die shown in Fig. 4 and Pressure Pad also employed for this Die

cast-iron plates. The nut *M* at the bottom of the stem can be adjusted to give any desired pressure that may be required for drawing the shell. The stem *K* is threaded to fit the tapped hole in the bottom of the die at *L*, Fig. 4. A hole is drilled through stem *K* which connects with the air hole or vent in plug *G*, Fig. 4. While dies can, of course, be constructed in the manner described in the article in November MACHINERY previously referred to, the use of

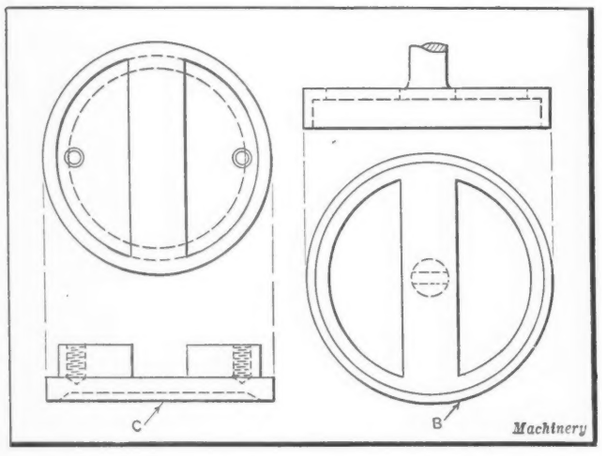


Fig. 6. Forming Block and Knock-out shown at C and B, Fig. 4

The scribing attachment, shown in Fig. 2, consists primarily of stem *L*, the lower end of which is provided with a sliding block *M* in which the scribing point *N* is fastened. A locating point, similar to point *N*, is fastened in the center of the stem *L*, as shown. The sliding block is so adjusted that dimension *P* is equal to the radius of the milling cutter *F*, Fig. 1. The pin *O*, Fig. 2, holds the scriber arm in a central position, but is a loose fit in a hole drilled in the sliding block *H*, Fig. 1. The stem *L*, Fig. 2, is also a sliding fit in the bearing *A*, which is an extension of the sliding block *H*, Fig. 1.

When the device is in use, the master cam blank *K* is fastened to the base of the fixture with dowels and machine screws. With the scribing point *N* set to the dimension *P* which is the radius of the milling cutter *F*, a line is scribed on the face of the master cam *K*; this line serves as a guide in rough-machining. After rough-machining, the cam is again clamped to the fixture and the profile generated to the finished size. The fixture can be strapped to the table of a drilling machine and power transmitted to the cutter-spindle by means of a flexible or universal-joint shaft, or a combination of shafts equipped with universal joints.

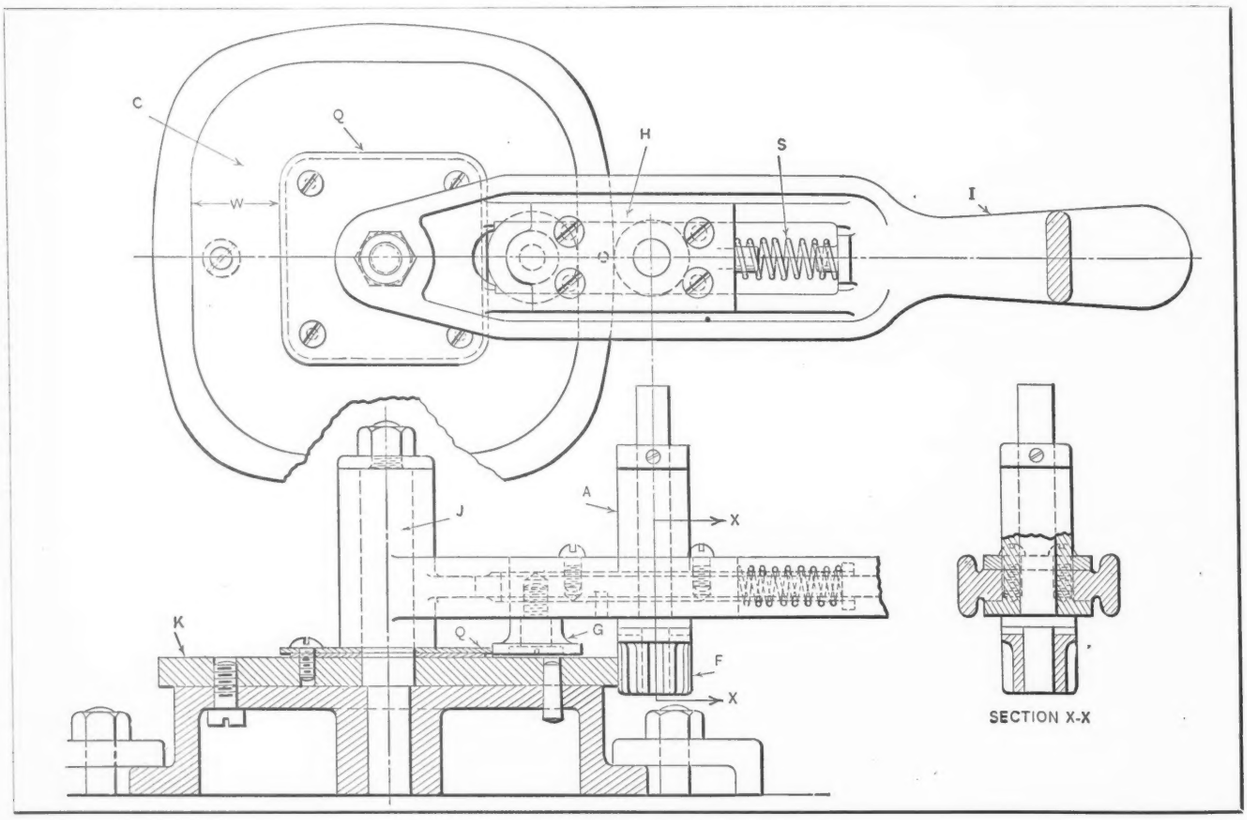


Fig. 1. Device for laying out and milling Master Cams

two-piece forgings, such as employed in the construction described in the present article, results in a much stronger punch and die, and should be used whenever possible.

* * *

LAYING OUT AND MILLING CAMS

By M. JACKER

The writer read with interest the article "Laying Out Master Cam Templets" in September MACHINERY. In Fig. 1 of the present article is shown another laying-out device in which provision is made for holding and guiding the milling cutter while generating the master cam *K*. This cam is used on a cam milling machine to guide the cutter when generating grooves in face cams. The form of the groove to be milled in the face cams is indicated at *C*, dimension *W* representing its width. The coil spring *S* serves to keep the roller *G* in contact with the periphery of the master templet *Q* so that the cutter *F*, mounted in a bearing *A* of a sliding block *H*, will mill the curve in the master cam *K* to the desired shape when lever *I* is rotated about stud *J*.

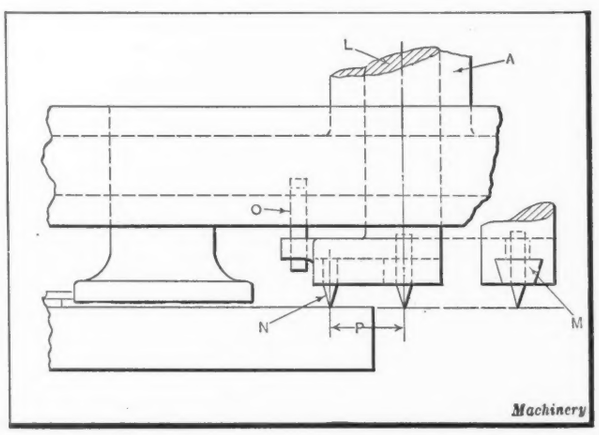


Fig. 2. Scribing Attachment used with Device shown in Fig. 1

ROUTING SHEET AND TOOL-CRIB INDEX

By ROBERT MAWSON

The routing sheet illustrated in Fig. 1 shows at a glance the procedure followed in machining an engine base. Routing sheets of this kind are simple to make up, and can be used with good results in nearly all kinds of machine-building plants. It will be noted that the sheet is headed by the name of the part to be machined and the drawing number. Following this, there is a list of the various operations required in the order in which they are performed. The detailed drawings of the various parts are marked with letters on the machined surfaces, and similar notations are made on the routing sheet.

Each department is given a number, and this number is displayed in some prominent position in the department. This helps the operator, routing engineer, and inspector to ascertain readily whether or not any mistake has been made in distributing or transferring the parts from one department to another. For example, if the routing sheet calls for Operation 3 to be done in Department 10, and the foreman finds the work placed in Department 14, he will know instantly that a mistake has been made by the man who does the trucking. In order to prevent leaving parts in the wrong department, it is best for the foreman or man assigned to this duty to place his initials opposite the name of the operation which is to be performed in his department when the parts are received. Before signing his name, he should make sure that no mistake has been made in the transference of the parts. It might be added here that columns could also be provided on the routing sheet for recording the date on which each operation should be commenced and the date when it should be completed. This will serve to place the responsibility for any delay in the work where it belongs.

It will be noted from Fig. 1 that the tools required for the fifth operation are a boring-bar having the numbers or identification mark T-825-B, and reamer T-1062-C. These numbers represent the drawing number of the tools. The letter following the number signifies the size of the drawing sheet on which the details are given. The letter A could be used to designate the smallest size of sheet used, B for the next larger size, and so on. With this method, it is a simple matter to find any drawing having the required information. In this instance, the drawing will be found in the drawer or file B under No. 825. As the drawings are filed in numerical order, any drawing can be quickly found.

The numbers shown on the routing sheet are stamped on the respective tools. If it is desired to refer to the drawing of any tool, it is only necessary that the tool number be known in order that the drawing may be located in its proper file. In some machine shops, it is the practice to mark the tools with the sequence number of the operation. However, it is not always advisable to do this, as it is sometimes necessary to change the routing of the piece, and this would require re-marking the tools. The better method is to mark only the tool number on the tool. The sequence number of the operation can be found on the routing sheet.

NAME – Engine Base		DRAWING – D-1219-C	
NO.	OPERATION	TOOLS USED	DEP'T.
1	Snag	———	14
2	Pickle, Sand Blast	———	18
3	Mill – A	2 – 6" Face Mills	10
4	Mill – B	Mills-Arbor-T-428-A	10
5	Bore – C	Boring-Bar T-825 – B Reamer – T-1062 – C	12
6	Drill – D – E	Jig – T-728-D Reamer T-814-A, $\frac{1}{2}$, $\frac{15}{32}$, $\frac{63}{64}$ – 1" Drill	17
7	Tap – D – E	$\frac{1}{2}$" – $\frac{3}{4}$" Std. Taps	17
8	Drill – F	Jig – T-701-D $\frac{5}{8}$, $\frac{15}{32}$ Drills $\frac{5}{8}$, $\frac{1}{8}$	17
9	Inspect	———	20
10	Paint	———	21
11	Mark-D-1219-C		21
12	Transfer to Stores		25
			Machinery

Fig. 1. Routing Sheet for Engine Base

NAME OF TOOL		NUMBER OF TOOL	
Drill Jig		T-1486-C	
SECTION	SHELF	DRAWER	DATE MADE
A	D	48	1/20/23 Machinery

Fig. 2. Tool-crib Card Index

Tool-crib Card Index

It is important that a means be provided for quickly locating the tools in the tool-crib. An index file with cards made out for each tool has proved to be a time-saving system. These cards may be of any size, as, for instance, 3 by 5 inches. They may be made up like the ones shown in Fig. 2, and filed in numerical order. This card gives the name or type of tool used, which in this case is a drill jig. The number of the tool, which is also the drawing number, is likewise placed on the card.

The tool number in the example shown is T-1486-C. The tool-crib or tool-room is divided into partitions of sections and shelves which are marked with different letters. The shelves are fitted with drawers which are identified by numbers. When a tool is put away in the tool-room, its location is marked on the card. In the example illustrated the location is indicated as section A, shelf D, and drawer 48. The number is, of course, obtained by the operator from the routing card, which is kept with the work while it is passing through the shop. When the workman has received the tool, he leaves a stamped check bearing the number of his machine. The man in charge of the tool-crib places this check on a hook outside the drawer or place from which the tool has been removed. A card index is kept in the tool-crib, which shows on what machine the tool is being used.

It should be noted that it is the machine and not the man that is designated by a number. The reason for this is that the man is often transferred to another department, whereas machines are permanently located. As an example, suppose that the milling fixture T-1823-C is not used and that the check left by the man who took out the fixture is No. 2-206. By referring to a card index, it will be found that the tool is in Department 10 and is being used on machine 498. It is not necessary to know the name of the man who is assigned to any job when this method is used. If any other workman should need the tool, it is an easy matter to find out from the man operating the machine when he will be through with it. This system should cause no confusion as the employment office will know where a new man is to begin work, and has a card index like that used in the tool-crib.

Identification checks for the machine to which the workman is assigned are given out by the man in charge of the tool-crib. If a workman is transferred to a different machine, he obtains another set of checks with numbers that agree with the machine he is to operate. When a tool is returned to the tool-room or crib, it should first be examined to ascertain that all the parts are intact and in a serviceable condition, after which the check is returned to the operator.

Interference Between Helical Gears on Parallel Shafts

By JOHN B. ARNOLD

A WIDE departure from standard practice is sometimes necessary in designing gears for machine tools in order to meet certain limitations imposed by the general design of the machine. In such cases it is desirable to obtain definite information as to the exact limits within which the gears may be safely modified. Recently the writer had occasion to redesign a helical ring gear and pinion to meet the requirements of a fixed ratio and center distance. From a preliminary survey of the problem it appeared possible to transmit the necessary power by using a large enough pitch to avoid an excessively wide-faced gear and still keep the number of teeth in the gear above the minimum necessary to avoid interference. However, this could not positively be determined at once, as all available formulas applied to spur gears only.

As the problem concerned helical gears, it was decided to deduce formulas that would apply strictly to the gears to be designed. If it should be found necessary to reduce the outside diameter of the gear to avoid interference, it would be necessary to know exactly how much to turn off the gear blank. It should be borne in mind that the following applies only to helical gears on parallel shafts.

It was assumed that when interference occurs it must exist in a radial plane. Obviously any variation between the results obtained with spur gear and helical gear formulas must be due to the change in the form of the tooth in the radial plane. The first problem, therefore, was to ascertain the characteristics of the helical gear tooth form in the radial plane.

The pressure angle, which was that of the 14½-degree involute, was considered first. The cutter selected for use in cutting the helical gear was designed for a spur gear having a number of teeth equal to the number in a gear of similar diametral pitch whose pitch radius was the radius of curvature of the helix. It then became clear that the effective pressure angle of the tooth form used would lie in the plane of the helix at some point, normal to the tooth, and, if projected into the radial plane, would become a different angle. It appeared important to bear this in mind, since the base circles of the gear and pinion are tangent to the pressure angle line drawn through the point of tangency of the pitch circles, and interference between the tops of the gear teeth and the bases of the pinion teeth exists when the point of tangency of the pressure angle and pinion base circle lies within the outside circumference of the gear.

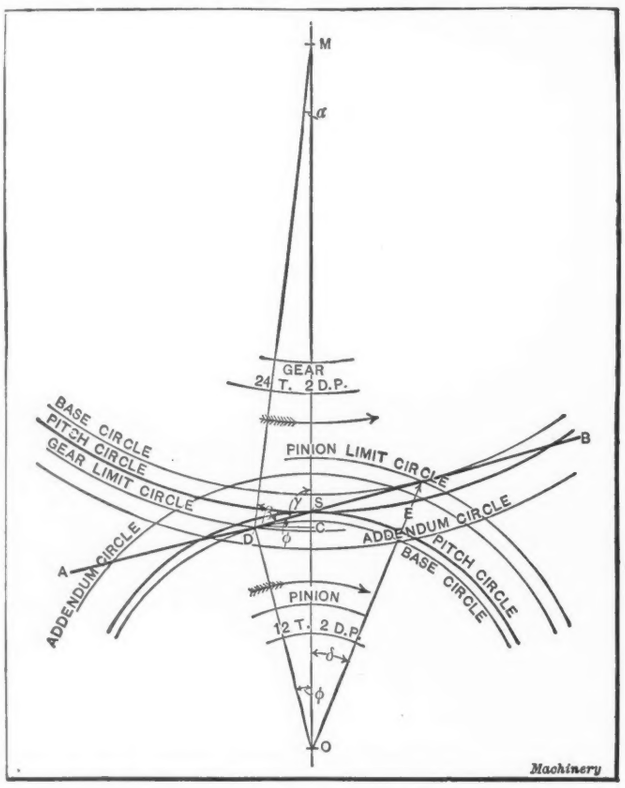


Fig. 1. Diagrammatical Lay-out for the Derivation of Formulas

If the helix angle be called θ, the normal pressure angle μ, and the pressure angle in the radial plane ϕ, as indicated in Fig. 2, $\tan \phi = \tan \mu \sec \theta$. This formula was proved by making a large-scale lay-out of the helical arcs, pressure angle, and base circles, and projecting these into the radial plane. The angle ϕ is larger than the angle μ, thus giving a smaller base circle than would the angle μ, which results in throwing the point of tangency farther from the center of the gear, thus permitting the use of fewer teeth in the gear for a given ratio without resulting in interference. Subsequent calculations proved this assumption to be correct.

In Fig. 1, let angle SDO be a right angle, and let angle SDC be called ϕ. As the figure shows a radial section through helical gears on parallel shafts, ϕ is the pressure angle in the radial plane, previously referred to. The line CD is perpendicular to line MO, drawn through the gear centers. Then angle SOD = angle $SDC = \phi$. Let the helix angle be called θ, and the normal pressure angle for the tooth system be called μ. In Fig. 2 these angles are shown projected for clearness.

To ascertain what value of θ will give full advantage of the helical drive with a minimum end thrust and minimum error resulting from any manufacturing inequality in the angles of the gear and pinion, let F = face width to be used, and P_n = normal diametral pitch.

Then,

$$\text{Sin } \theta = \frac{\pi}{P_n \times F} \qquad (1)$$

As before stated,

$$\text{Tan } \phi = \tan \mu \sec \theta \qquad (2)$$

Now referring to Fig. 1, let $SD = a$ and $SC = x$. Then

$$\frac{x}{a} = \sin \phi \qquad (3)$$

Now let n = number of teeth in the pinion; and
N = number of teeth in the gear.

Then

$$SO = \frac{n}{2P_n \cos \theta} \quad \text{and} \quad \frac{SD}{SO} = \frac{2a\,P_n \cos \theta}{n} = \sin \phi$$

Hence

$$a = \frac{n \sin \phi}{2P_n \cos \theta} \qquad (4)$$

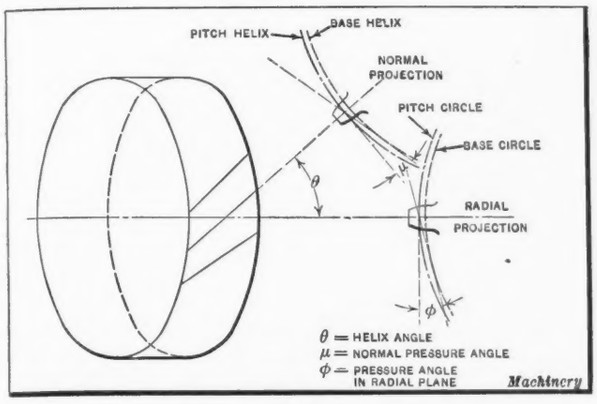


Fig. 2. Diagram showing how Tooth Form in Radial Plane differs from that in Normal Plane

Substituting in Formula (3) and transposing,

$$x = \frac{n \sin^2 \phi}{2P_n \cos \theta} \qquad (5)$$

In triangle CDO, Fig. 1, we have $\frac{CD}{CO} = \tan \phi$

But $CO = SO - SC = \frac{n}{2P_n \cos \theta} - \frac{n \sin^2 \phi}{2P_n \cos \theta} = \frac{n \cos^2 \phi}{2P_n \cos \theta}$

Hence

$$\text{Tan } \phi = CD \div \frac{n \cos^2 \phi}{2P_n \cos \theta} \qquad (6)$$

Let angle $CMD = a$. Then

$$\text{Tan } a = \frac{CD}{CM} = \frac{CD}{SM + SC}$$

But

$$SM = \frac{N}{2P_n \cos \theta}$$

Hence

$$\text{Tan } a = CD \div \left(\frac{N}{2P_n \cos \theta} + \frac{n \sin^2 \phi}{2P_n \cos \theta} \right)$$

$$= CD \div \frac{N + n \sin^2 \phi}{2P_n \cos \theta} \qquad (7)$$

Dividing Formula (6) by Formula (7), we have:

$$\frac{\text{Tan } \phi}{\text{Tan } a} = \frac{N + n \sin^2 \phi}{n \cos^2 \phi} = \frac{N}{n \cos^2 \phi} + \tan^2 \phi$$

Hence

$$\text{Cot } a = \frac{N}{n \cos \phi \sin \phi} + \tan \phi \qquad (8)$$

from which a can be determined for any ratio $\frac{N}{n}$.

We have further $a + \beta + \gamma = 180$ degrees. But $\gamma = 90$ degrees $+ \phi$. Therefore $\beta = 90 - \phi - a$. (9)

Further,

$$\frac{DM}{\sin \gamma} = \frac{SM}{\sin \beta}$$

But

$$SM = \frac{N}{2P_n \cos \theta}$$

$$DM = \frac{N}{2P_n \cos \theta} + \frac{1}{P_n} \text{ and } \sin \gamma = \cos \phi$$

Hence

$$\frac{N + 2 \cos \theta}{2P_n \cos \theta} = \frac{N}{2P_n \cos \theta \sin \beta}$$

or

$$N = \frac{2 \cos \theta \sin \beta}{\cos \theta - \sin \beta} \qquad (10)$$

As β is known from Formula (9), N can be found, giving the smallest number of teeth in the gear for a given ratio to avoid interference without shortening the addendum.

Assume, now, that it is impossible to use so great a number of teeth under the conditions of the design. It then becomes necessary to shorten the addendum of the gear to avoid interference. To ascertain how much must be turned off, first determine what pitch would be required to put the theoretical number of teeth in the pitch circle required. Let D = the pitch diameter required. Then

$$P_n = \frac{N}{D \cos \theta}$$

and the addendum should be

$$\frac{1}{P_n} = \frac{D \cos \theta}{N} \qquad (11)$$

This shortened addendum must not result in causing one tooth to come out of mesh before the next is engaged. Although the helix angle used was based on an advance of one tooth in the face width, it would seem doubly safe to consider this in the radial plane only. Referring again to Fig. 1, we have by the same process as was used in obtaining Formula (8),

$$\text{Cot } \delta = \frac{n}{N \cos \phi \sin \phi} + \tan \phi \qquad (12)$$

Then if x be the number of teeth in contact at one time,

$$x = \frac{n (\phi + \delta)}{360} \qquad (13)$$

where x must exceed unity.

In Fig. 3 are shown a pair of gears A and B designed for a lathe, which proved on test to have interference so great as to cause tooth marks on the work. In redesigning, it also appeared that the helical angle of these gears exceeded the angle required for smooth action, thus causing excessive end thrust. These gears as redesigned are shown at C and D. The process of computation in this case is given in the following:

In the preceding formulas let $P_n = 5$, $F = 2.75$ inches, and $\mu = 14\frac{1}{2}$ degrees.

From Formula (1), $\theta = 13$ degrees 12 minutes 28 seconds.

The center distance of 11.95 inches is fixed, and as the ratio must remain 1:4, the pitch diameters of both gear and pinion are also fixed at 19.120 inches and 4.780 inches, respectively. By trial it is found that the angle nearest to, yet greater than, θ as found in the foregoing, which will give on the required pitch diameter a number of 5-pitch teeth divisible by 4, is 15 degrees 46 minutes 20 seconds, giving 92 teeth. Then

$\theta = 15$ degrees 46 minutes 20 seconds

From Formula (2), $\phi = 15$ degrees 2 minutes 32 seconds

From Formula (8), taking $\frac{N}{n} = 4$, $a = 3$ degrees 31 minutes 34 seconds

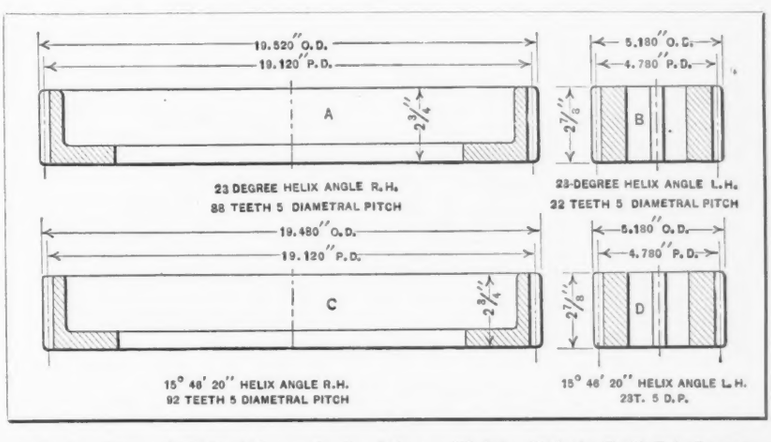


Fig. 3. Gear and Pinion before and after being modified to eliminate Tooth Interference

From Formula (9), $\beta = 71$ degrees, 25 minutes, 54 seconds
From Formula (10), $N = 102.56$ teeth
From Formula (11), $\frac{1}{P_n} = 0.1799$ inch

As the standard addendum for 5-pitch teeth is 0.2 inch, the outside diameter of the gear must be 0.0402 inch smaller than standard, or 19.48 inches. To ascertain whether this shortened addendum will permit the gears to remain properly in mesh, we have,

From Formula (12), $\delta = 38$ degrees 18 minutes
From Formula (13), $x = 3.4$ which, being greater than unity indicates satisfactory action.

* * *

PREVENTING TAP BREAKAGE

By ARTHUR PESTEL

It is a peculiar fact that almost no thought is given to the sharpening of a tap, while it is the general practice to grind a drill or lathe tool at regular intervals or as soon as there is any indication of dullness. Until the user recognizes the fact that a tap is like any other metal-cutting tool and needs resharpening just as frequently, the number of broken taps will not be reduced materially.

The use of friction-releasing mechanisms on tapping machines will be of little benefit unless the torque that the tap will safely withstand is known and the mechanism set to slip before this torque has been exceeded. Having installed a friction device and adjusted it to slip before sufficient force is exerted on a tap to cause breakage, there still remains the problem of instructing or educating the operator to keep the mechanism properly adjusted and to have the tap resharpened as soon as it becomes dull. The too frequent slipping of the friction mechanism should indicate to the operator that the tap has become too dull for further use and should therefore be resharpened or replaced by a sharp tap. Instead of doing this, many operators simply adjust the friction mechanism to carry a little heavier load, so that the dull tap will be forced through the work. Of course this method of adjustment serves to defeat the purpose for which the friction-releasing mechanism is employed.

If the regulation and adjustment of the releasing mechanism is left entirely to the operator or mechanic, it is likely that he will change the adjustment until he is sure that it will exert sufficient driving power (without slipping) to carry the tap through the work, although he is not sure that the device will release before the tap breaks. Also if it seems to him that the mechanism releases too frequently, he is likely to increase its driving capacity until it approaches the limit of the breaking strength of the tap.

Obtaining Correct Adjustment of Releasing Mechanism

A method can be developed for correctly adjusting the releasing mechanism if the breaking strain of the tap is known. This method requires the use of an indicating device for measuring the torque of the releasing mechanism. The operator should be supplied with such an indicator and be instructed to adjust the mechanism for a definite torque for each size of tap when operating at a specified speed. If the tap becomes dull or is hindered in its work by chips, the releasing mechanism will automatically indicate the trouble. If the driving power of the releasing mechanism remains constant, the operator will be informed automatically by the too frequent releasing of the friction mechanism that the tap is either dull and should be sharpened or is hindered from its proper functioning by some other cause.

Data on Tap Characteristics

If an indicating device for the proper adjustment of the releasing mechanism of a tapping device is employed, it is essential that correct data be available on the characteristics of the taps to be used. The cutting speed and the mean torque, in inch-pounds, to which taps may be subjected before reaching their elastic limit should be known. The writer recently approached a number of leading manufacturers of taps on this subject. In response to these inquiries, the Greenfield Tap & Die Corporation, Greenfield, Mass., furnished the following data:

Safe Load on Taps

Size	Inch-pounds	Size	Inch-pounds
No. 4	35	1/4"	100
No. 6	47	No. 16	128
3/16"	55	No. 18	157
No. 10	66	5/16"	185
No. 12	87	3/8"	213

The loads given in the foregoing table are one-third below the breaking strain of the taps, and are considered safe when the surface cutting speed of the tap is 28 feet per minute. With the strength of the tap and its cutting speed known, the proper adjustment of the releasing mechanism becomes one of supplying the operator with a simple indicating device, which will enable him to measure the torque of the releasing mechanism in accordance with the known strength of the tap. The design of such an indicating device was described in an article in August, 1920, MACHINERY on page 1155. This device consists primarily of a tension spring attached to a lever arm which can be connected to and operated by the safety releasing mechanism. A pointer that forms part of the lever arm travels over a scale graduated in inch- or foot-pounds.

* * *

BORING A SPHERE TO REDUCE ITS WEIGHT

By J. A. G. GOULET

In December MACHINERY, page 301, a formula is given for determining the diameter of a hole to be drilled through a sphere in order to reduce its weight a given amount. The formula in the form given, is difficult to solve except by one who is very well versed in mathematics. I believe that it is too formidable for most readers of MACHINERY, and am therefore presenting a simpler formula that will give the same result. In the following,

d = diameter of hole to be drilled;
D = diameter of sphere;
p = final weight of sphere after hole has been drilled; and
P = initial weight of sphere.

Then,

$$d = D\left[1 - \left(\frac{p}{P}\right)^{2/3}\right]^{1/2}$$

This can also be written as follows:

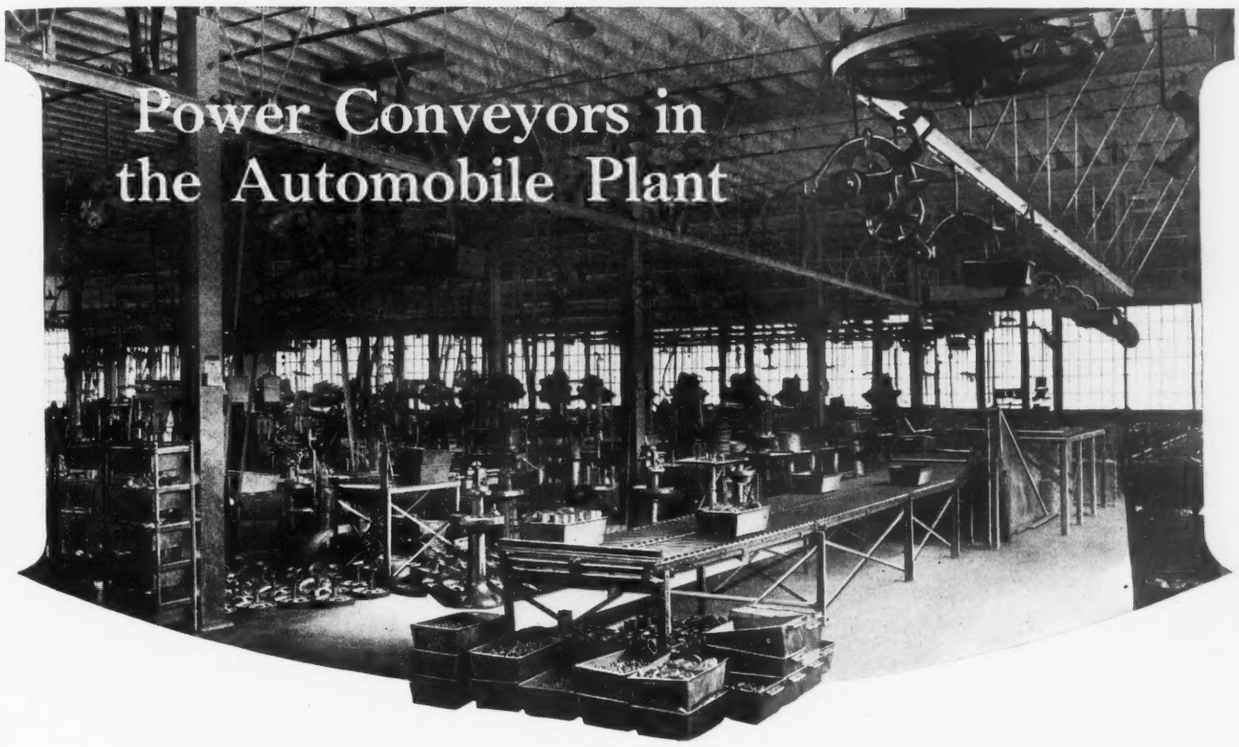
$$d = D\sqrt{1 - \sqrt[3]{\left(\frac{p}{P}\right)^2}}$$

* * *

"PERMALLOY"

"Permalloy" is an alloy of nickel and iron which is characterized by extremely high magnetic permeability at low magnetizing forces. Its extraordinary "magnetic permeability" means the ease with which magnetic "lines of force" penetrate it and make of it an electromagnet. It is by far the most easily magnetized and demagnetized of all metals now known. The particular composition which is best in this regard contains about 80 per cent nickel and 20 per cent iron. The mere mixture of the two metals, however, is not sufficient to secure the highest permeability. A special heat-treatment is also required. When properly heat-treated, its initial permeability is more than thirty times that of soft iron. It is because of these remarkable magnetic properties that its use in the manufacture of submarine cables will permit messages to be transmitted at speeds many times those now obtainable.

Power Conveyors in the Automobile Plant



IF it were not for the subway and elevated systems in New York City, it would be impossible for the hundred-thousands of workers to get to and from their places of employment, and the metropolis could never have grown to its present population. Similarly, the great production of our large industrial plants would be impossible if they did not have conveyor installations for accelerating the delivery and removal of parts to and from certain machines and the assembly of finished parts and units into the complete product. Machines and assembly benches would necessarily be clogged because of the difficulty of supplying unfinished or unassembled parts and removing finished work or assembled units. In plants provided with such modern equipment, a great quantity of work is accomplished with smoothness and dispatch, whereas in other shops there may be much hustle and bustle with considerably less production.

When the subject of high-production methods in the metal-working field is discussed, the automobile industry must be considered, as the requirements of this industry are primarily responsible for the development of many semi-automatic and automatic machine tools and for the extensive use of conveyor systems. Power conveyors are used not only for speeding up the assembly of the various units into complete automobiles but also for feeding work to and from machines, carrying work through japanning operations, and assembling the various units. Several examples of modern conveyor installations in automobile plants will be described in the following. The link chains and sprockets

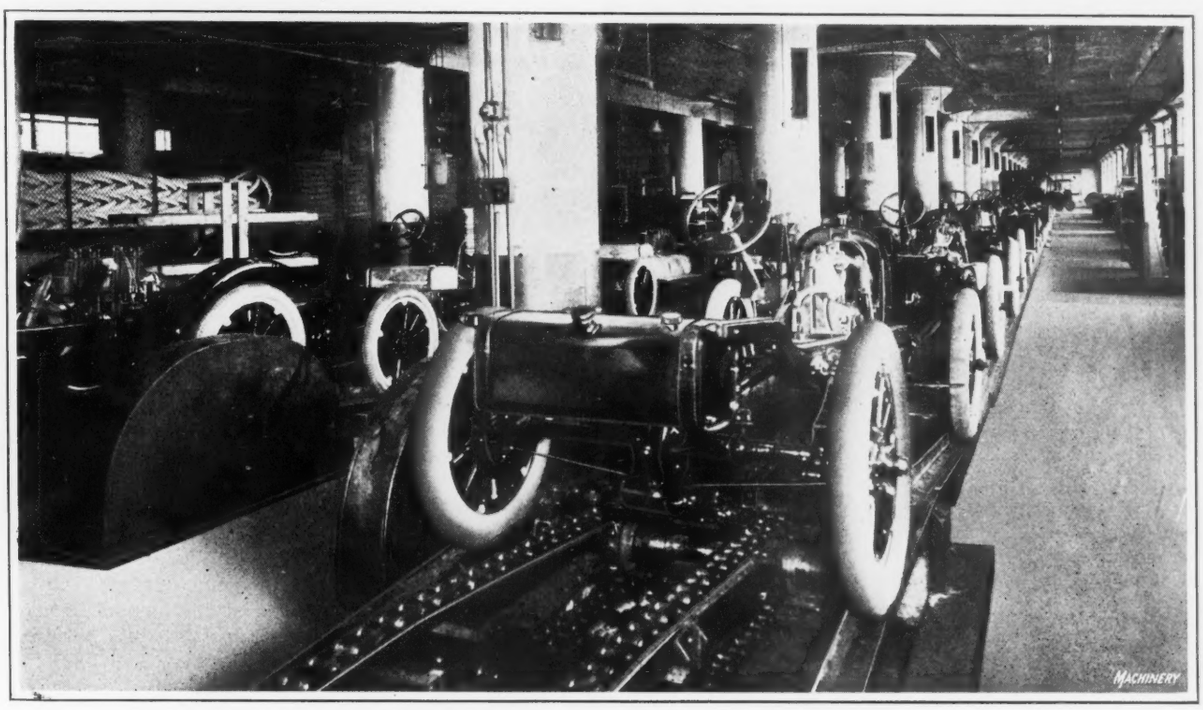


Fig. 1. Conveyor of the Type commonly used in assembling the Various Units and Parts into the Complete Automobile

for each of these conveyors were supplied by the Link-Belt Co., Chicago, Ill.

Advantages of Overhead Conveyors

Gravity conveyors and rollways are in common use in shops where the distance through which parts are conveyed is not so great as to require an impractical height at the loading end, where the space required for the conveyor can be conveniently spared, and where the design of the parts themselves permits them to be transported by gravity. When these conditions do not exist, a power conveyor is usually the remedy. One particular advantage of power conveyors is that certain types can be readily arranged overhead for carrying parts about the shop without occupying any floor space whatever. There are several interesting conveyors of this type in the plant of the Willys-Overland Co., Toledo, Ohio. That shown in the heading illustration is used for carrying parts contained in the clutch, engine-bracket, and smaller units to the points where these units are assembled and afterward carrying these partial assemblies to the points where they are assembled into the complete motor.

A conveyor of this design eliminates all trucking ordinarily necessary in this work and does not require any floor storage, the parts being delivered to the motor assembly line at the proper rate of speed for immediate use. In the foreground of this illustration is seen a short gravity conveyor that receives metal containers filled with pistons and other parts from a power apron conveyor that delivers the work from the floor beneath. At the time the photograph was taken the overhead conveyors were not completely loaded, and they would easily take 100 per cent more work than is shown. It will be seen that the conveyor chain is supported at regular intervals by small two-wheeled trolleys that run on the upper legs of angle-irons placed back to back with sufficient space between to permit passage of the links. Rods and hooks for carrying the work are attached to the under side of the links supported by the trolley.

Other conveyors of this general type are employed to carry radiators, fenders, running boards, head-lights, batteries, etc., transversely across conveyors on which the automobiles are completely assembled. These parts are placed on conveyors on the floor beneath the assembly department and are carried across the main assembly lines at a speed that is synchronized with the speed of these lines so that there will be neither a scarcity nor a surplus of these parts. The main assembly lines usually have two tracks made up of channel irons and one or two link chains with devices at regular intervals that extend upward to pull the automobile chassis the length of the conveyor. At the loading end of the conveyor the chassis is carried on special four-wheeled carriages until the wheels have been assembled, after which the unit is supported by the tires.

Fig. 1 shows a conveyor of this type that has recently been installed in the plant of the Chevrolet Motor Co., St. Louis, Mo. When the automobiles reach the far end of the conveyor, they are completely assembled. In the system illustrated, the various parts and units are taken from trucks situated along the line.

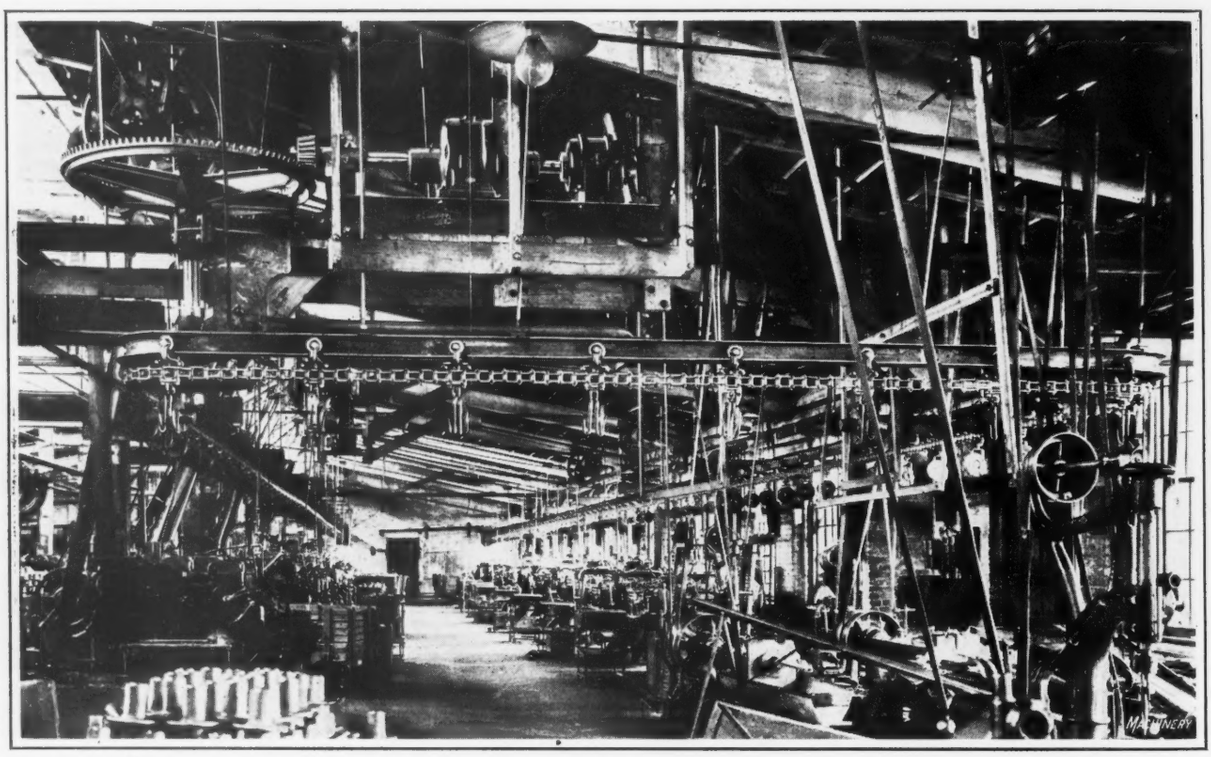


Fig. 2. Overhead Installation for carrying Malleable Castings to and from Machines for the Successive Machining Operations

Carrying Work to and from Machines

Overhead conveyors have also proved efficient in carrying work to and from machines, and in the plant of the Hayes Wheel Co., Albion, Mich., there are over two thousand feet of conveyor installations of the mono-rail type, as shown in Fig. 2. The particular conveyor illustrated carries rough malleable-iron wheel hub castings in the condition in which they come from the foundry through the machining department at a height enabling the various operators to reach and remove parts as required. When an operator removes an unfinished part from the conveyor, he replaces it with one taken from the machine which is ready for the next operation. The machines are so grouped that the operations are performed in the proper sequence, and each part is completely machined when it is carried from the room by the conveyor.

The loading and unloading stations of this conveyor are adjacent, as shown in Fig. 3, the rough parts being taken from the trucks in which they come from the receiving department and hung on hooks on the conveyor, and the finished parts being placed in trucks for transportation to the next department. As with all power conveyors, the outstanding feature of this installation is the elimination

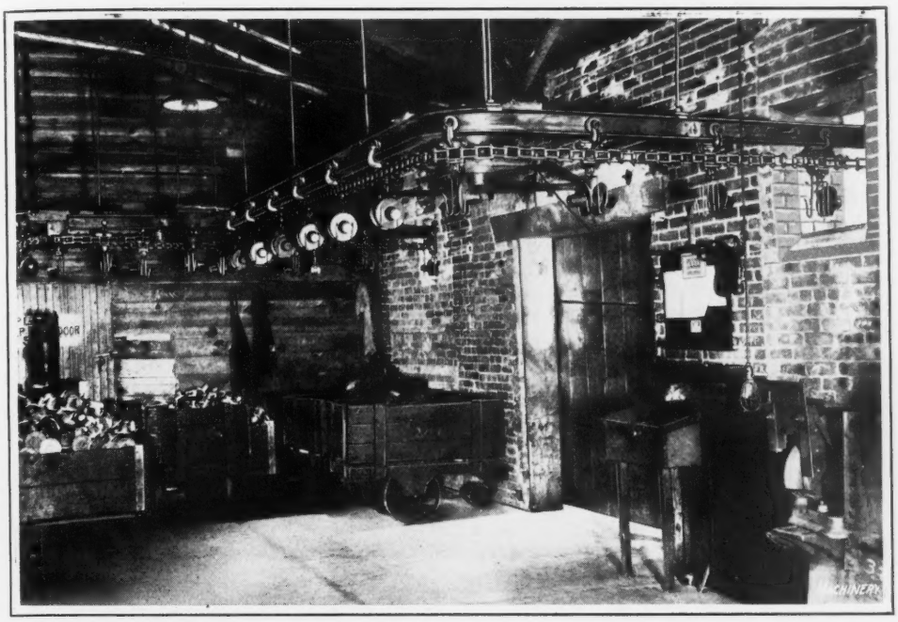


Fig. 3. Room where the Finished Parts are replaced with Rough Castings

of congestion in supplying the machines with rough work and in removing the finished pieces. In the department served by this conveyor, four men with trucks were formerly necessary to keep the machines in constant operation, whereas now only one man is required to load this conveyor and another, that carries rough parts through another shop. Thus by means of two conveyors, seven trucks and operators have been eliminated. Another advantage of the conveyor is that the total amount of partly completed work passing through the department is greatly reduced. Formerly at least four thousand hubs in various stages of completion would be in the department at one time, while now there are never more than four hundred hubs.

It will be seen from Fig. 3 that the rail of the conveyor is an I-beam and that the chain is supported by two-wheeled trolleys running on the lower flanges. Stirrups for holding the work are fastened to the chain links. The drive for this installation is shown in Fig. 2, close to the ceiling; it consists of a motor which drives, through a reduction unit and bevel gearing, a sprocket located in a horizontal plane. There are but five sprockets in the entire unit.

Japanning Conveyor

Another application of power conveyors that effects considerable savings in time and labor is in the japanning of the large number of small and medium-sized sheet-metal parts used in automobiles. In one plant, for instance, it is the practice to hand-dip fenders in the japan, hang them on the overhead rods of a conveyor to drain, and then operate the conveyor, which carries the work into the baking oven, the conveyor stopping until the baking is completed. The conveyor is twice the length of the oven so that the loading and unloading end extends from the oven a distance equal to the length of the oven. While parts are being baked, finished parts are removed from the extension, and other parts just dipped are hung on the conveyor to drain. By the time the parts in the oven are baked sufficiently, the freshly dipped parts have drained the desired amount.

A more modern practice is to employ a continuous conveyor which automatically dips the work into the japanning tank, carries it over dripping pans, and conveys it through the baking oven. The speed of the conveyor, and the length and temperature of the oven must be such that the parts will be completely baked when they reach the unloading end. A conveyor of this type has recently been installed at the Lansing, Mich., plant of Durant Motors by the Paul Maehler Co., Chicago, Ill. From Fig. 4 it will be seen that there are two Link-Belt chains spaced about 4 or 5 feet apart and connected by round bars approximately one inch in diameter.

The work is hung on these bars and carried by them through the different steps of the operation. At the loading point the bars are at a height that can be easily reached by the attendants, and as the bars approach the japanning tank they rise in order to clear the tank. They then drop to immerse the work in the japan, after which they rise again to clear the far side of the tank. Then they drop once more before entering the oven. The chains and bars return on overhead tracks, and the power unit is also installed overhead.

* * *

An electric motor of unusually large capacity has recently been built by the General Electric Co. for an iron and steel company in India. This motor is of 6300 horsepower, weighs 238 tons, and has an over-all length of 25 feet, a width of 15 feet, and a height of 12 feet 8 inches. It will be used to drive a combination rail and structural steel mill.

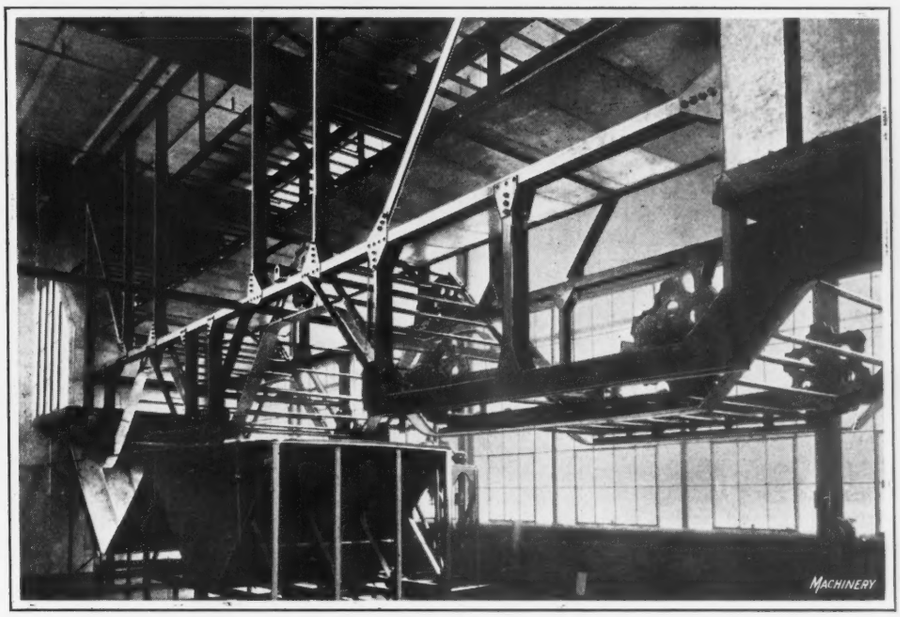


Fig. 4. Large Conveyor for carrying Fenders, etc., through the Complete Japanning Operation

Swinging-leaf Clamping Devices

By F. SERVER

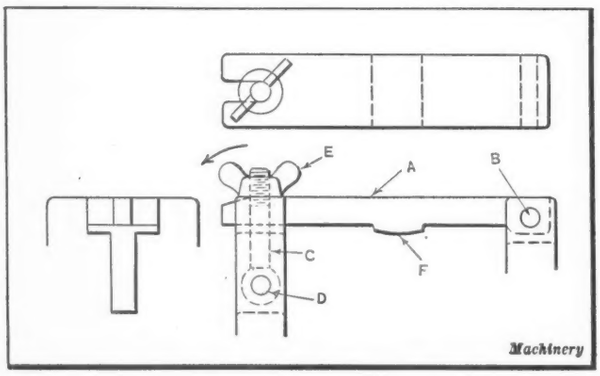


Fig. 1. Plain Hinged Cover with Wing-nut

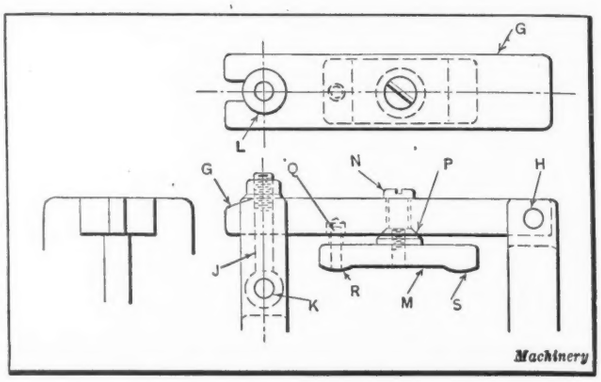


Fig. 2. Hinged Cover provided with Equalizing Clamp

SWINGING covers, or swinging-leaf clamping devices, are made in various forms for clamping work in jigs and fixtures and also for holding drill guide bushings. The chief advantage of devices of this kind is that they allow sufficient room for the quick insertion or removal of the work when the cover is swung back. Covers in which drill bushings are inserted must, of course, be in accurate alignment when they are clamped down. This necessitates a substantial clamping device and machined bearing seats against which the swinging cover can be secured.

It should not be inferred, however, that it is always best to incorporate a hinged cover in a jig or fixture design. In fact, if the nature of the work will permit, it is usually preferable to have the clamping members and guide bushings in one substantial housing, avoiding loose pieces or hinge connections of any kind. However, it is not always possible to do this, and the hinged cover often proves to be the most satisfactory means of attaining the desired results.

Two work-clamping hinged covers are shown in Figs. 1 and 2. The design shown in Fig. 1 has but one clamping point *F*, while that shown in Fig. 2 has an equalizing device which bears on the work at two points. The cover *A*, Fig. 1, is attached to the frame of the jig by means of the pin *B* upon which it hinges. At the opposite end, and also attached to the jig, is an eyebolt *C* which is held in place by the hinge-pin *D*. The wing-nut *E* at the upper end of the eyebolt is used to hold the cover *A* down against the work. The cover is slotted to permit eyebolt *C* to swing in the direction indicated by the arrow so that the cover can be swung about pin *B* as a center in order to enable the work to be removed. The raised surface *F* on the cover presses against the work when nut *E* is tightened, and serves to clamp the work in place.

Hinged Cover with Equalizing Clamp

Referring to Fig. 2, the cover *G* is hinged at *H* and has an eyebolt *J* pivoted at *K*. A hexagonal nut might be used at the upper end of the eyebolt in place of the round nut shown at *L*, to provide a means of clamping down the swinging cover. A wrench may be used to tighten the hexagonal nut when clamping. Attached to the under side of the swinging cover is an equalizing clamp *M*, which is held in position by a screw *N*. The ball collar *P*, having a spherical surface on the upper side, is interposed between clamp *M* and the cover. Screw *N* is a floating fit in the cover and a small pin *Q*, which enters a hole drilled in the under side of the cover, serves to hold the clamp in approximately the correct position.

On clamp *M* are two raised surfaces *R* and *S* which come in contact with the work when the hinged cover is clamped down by nut *L*. The floating construction described permits the clamp to equalize itself on the work so that the latter will be securely held down at two points. The designs shown in Figs. 1 and 2 are not satisfactory for clamping work in a jig when drilled bushings are contained in the hinged cover, as the cover cannot be permitted to adapt itself to the irregularities of the work, but must swing into a definite position or alignment in relation to the body of the fixture. With bushings, the use of hold-down screws should be avoided, as these may spring the cover and destroy the alignment of the bushings. When hold-down screws must be used, the cover should be made strong enough to resist any bending strains set up by the clamping action.

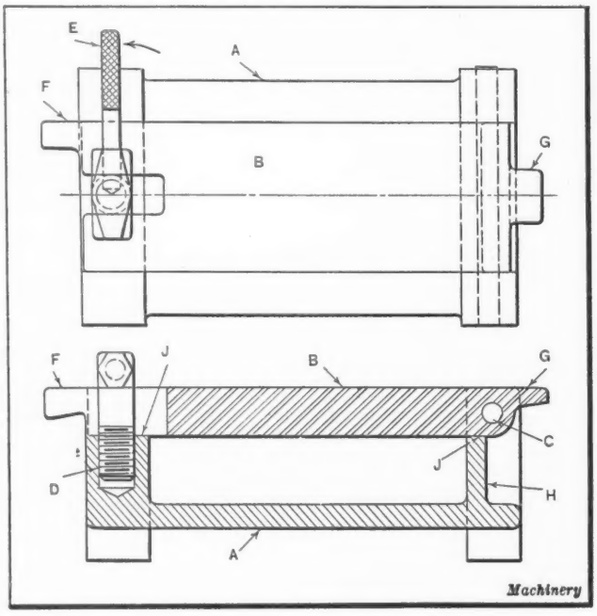


Fig. 3. Swinging or Hinged Cover for holding Drill Bushings

Swing Cover Adapted for Holding Bushings

In Fig. 3 is shown a swinging cover that is well adapted for holding bushings. Holes are bored through the cover at the proper points, and hardened steel bushings for guiding the drills are forced into the bored holes. The frame of the jig is shown at *A*, while the cover is indicated as *B* in both the plan and elevation views. The cover pivots on the hinge-pin *C*, and the

screw *D* holds it in position on the jig body. Screw *D* is made with a rectangular shaped head, and has a knurled pin *E* driven into a hole in one side, which serves as a handle for locking and unlocking the hinged cover. When the screw is in the position shown, the cover is held down in place. When it is turned a quarter of a revolution in the direction indicated by the arrow, the enlarged portion or head of the screw is in alignment with the slot in the cover and permits the latter to be swung up. The head of screw *D* is beveled on the under and upper sides so that it will readily enter the slot in the cover.

The projecting lug *F* provides a handle by means of which the operator can swing the cover back into the loading position. The projecting end *G* serves to prevent the cover from being thrown back far enough to damage the machine table or itself. The finished surfaces *J* at each end of the fixture facilitate the accurate manufacture of the tool, as the swinging cover jig is clamped down against these surfaces while the hole for the hinge-pin *C* is being machined.

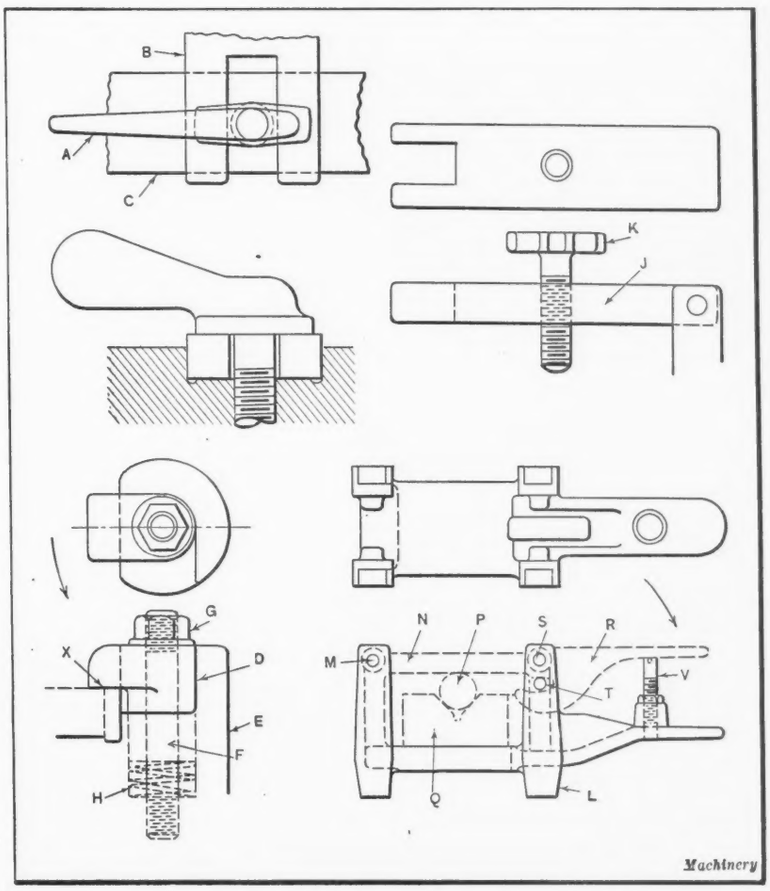


Fig. 4. Types of Clamping Devices used for Hinged Covers

Methods of Clamping Hinged Covers

A number of clamping units used in connection with hinged covers are illustrated in Fig. 4. The clamping device shown in the upper left-hand corner consists of a lever *A* having a threaded end. This is used for the same purpose as the screw *D* in Fig. 3. The screw is forged to shape and is the type employed by some of the larger manufacturers of jigs. A portion of the hinged cover is indicated at *B* while part of the jig frame is shown at *C*.

In the lower left-hand corner of the illustration is shown a clamping bolt which may be used for holding down a hinged cover, although it is more generally employed for holding work in place. This device consists of a bushing *D* entering a hole in the casting *E*, which corresponds to the base of the jig or fixture. Passing through a bushing *D* is a screw *F* with a nut *G* and a washer at the upper end. Beneath the bushing is a spring *H* which forces it upward when nut *G* is loosened. When bushing *D* is thus released, it can be turned in the direction of the arrow so that the hooked end will not be over the work. The work can then be readily removed or the hinged cover can be swung upward. The casting *E* is machined with a shoulder that limits the movement of bushing *D* to a quarter revolution.

In the upper right-hand corner of Fig. 4, is shown a hinged cover *J* with a clamping screw and a hand knob *K*. In using a clamping device of this kind, it is customary to clamp the cover down against finished surfaces like those shown at *J*, Fig. 3, although this is not always necessary.

In the lower right-hand corner (Fig. 4) may be seen a complete swinging cover. This consists of a base, a cover, and a clamping device. For clearness, some of the less important details, such as screws, pins, etc., have been omitted. The base *L* of this fixture has a hinged clamping cover *N*, which is pivoted on pin *M*. The work *P* is located in a V-block *Q*. Pivoted to cover *N* is a lever *R* which swings on pin *S*, and which has a cam surface at the under side coming in contact with a pin *T*. This cam surface is in the nature of a hook that extends under the pin, so that when it is in the position shown the cover is securely held in place.

The stop-screw *V* limits the clamping movement of lever *R* so that the powerful action of the lever will not cause distortion or breakage of the clamping member, as might easily happen if it should be pressed down too far. When cover *N* is swung back to allow the work *P* to be removed, lever *R* is given a pull in the reverse direction from that indicated by the arrow and the continued movement of this lever serves to swing up the hinged cover. Thus one movement serves to release and swing back the hinged cover.

Hinge-pin with Vertical Adjustment

Cases sometimes arise where it is necessary or desirable that the hinged cover have a slight vertical adjustment. This can be accomplished by making the bearing for the hinge-pin a separate unit on the frame of the jig so that it can be shimmed up to the proper height, or a hinge-pin constructed as shown in Fig. 5 may be used. In the illustration, *A* indicates a portion of a hinged cover, while *B* represents a hinge-pin upon which the cover swings.

This hinge-pin differs from the usual type in that both ends are turned eccentric at *C* and *D*. A screwdriver slot is also cut in the end of the pin at *D*.

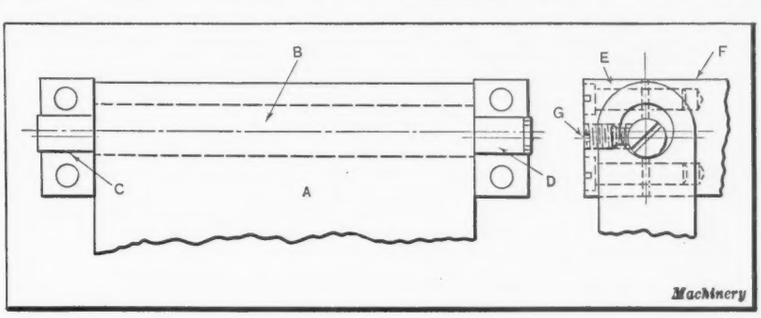


Fig. 5. Hinge-pin with Provision for Vertical Adjustment

The hinge-pin is held in place on the fixture *F* by a cap *E*, which, in turn, is held in position by machine screws. The eccentric pin *B* is revolved until the hinged cover *A* is adjusted to the correct height, when it is held in place by tightening screw *G*. This device is sometimes employed when it is desired to adjust the hinged cover so that it will be square with a finished surface on the part held in the fixture.

In Fig. 6 is shown a complete fixture used for holding the piece shown by the dot-and-dash lines at *A*. The base *B* is made of cast iron, and the work is held in a steel block *C*. The work *A* is pushed against block *C* by a slide *D*, which fixes the shoulder *E* against a corresponding surface on block *C*. The tongue on the work, however, passes between the two surfaces *F*. Slide *D* is operated by the cam *G* attached to lever *H*, and the simple action of pushing the lever over causes the slide to move the work up into position. The work is then supported from below by means of a pin *J*. This pin is forced against the work by the beveled pin *K*, which is pushed up into position through the medium of a hand knob *L* and a screw *M*.

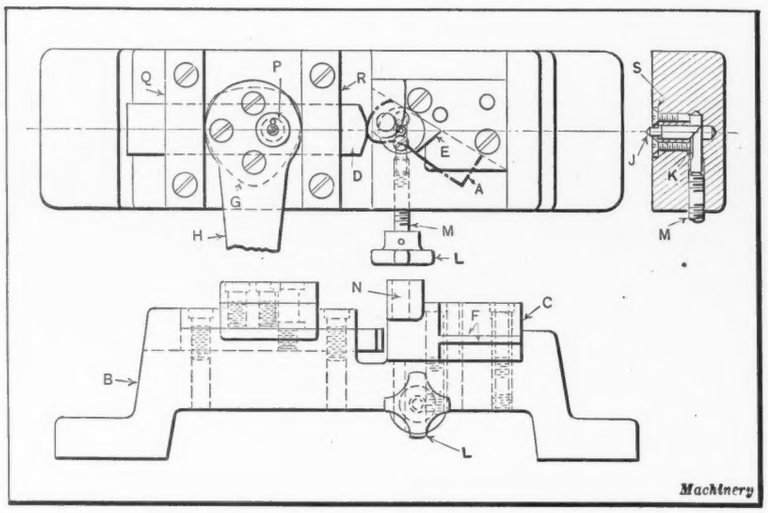


Fig. 6. Fixture provided with Cam-operated Clamping Device

It will be evident that this arrangement is quick-acting and that slide *D* can be quickly traversed the distance necessary to bring it into contact with work *A*. In order to load the fixture, the slide must be withdrawn far enough to allow the boss on the work to clear the beveled surface *E* on the jig. The hole *N* serves as a guide for the drill. It should be noted that cam *G* pivots about stud *P* as a center.

The cam-operated slide *D* may sometimes be used in place of a hinged cover; the slide can be pushed back by means of a lever in order to allow the work to be put in position, after which it can be advanced by lever *H* until the end comes against a shoulder on the work or against a stop on the fixture. The drilling can then be done through a bushing held in the end of slide *D*. Various adaptations of this arrangement will suggest themselves for different machining operations. It should be observed that the cam operates in a groove made by two plates *Q* and *R*, which are set crosswise on the fixture, while a ring *S*, held in position by means of machine screws, keeps pin *J* in place.

Hinged Cover Fixture for Lathe Chuck

In Fig. 7, is shown a hinged cover incorporated in a fixture designed for use on a lathe or chucking machine. The work is shown in the upper left-hand corner of the illustration. The fixture is shown, in part section, attached to the spindle nose *A* by means of a thread adapter *B* to which the fixture *C* is held by screw *D*. To part *C* is attached by screws a steel block *R*. This block has a V-shaped groove cut in its upper side at *X*.

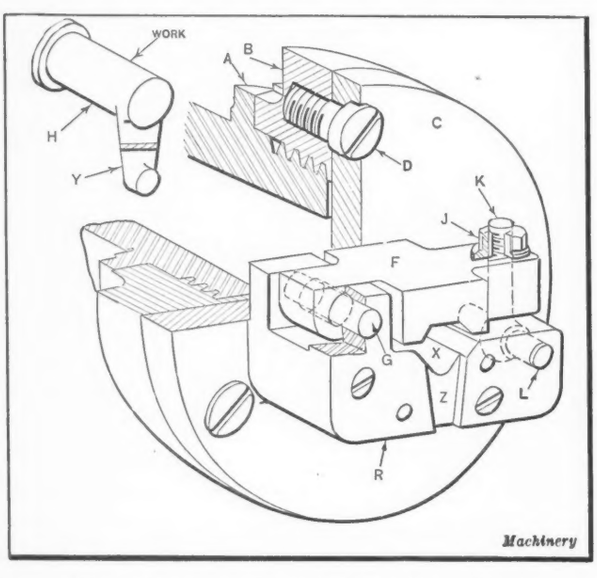


Fig. 7. Lathe Chuck equipped with Hinged Cover Fixture

The hinged cover *F* is held in place by means of the pin *G*. The work is put in position in the center of the fixture at *X*, with the projecting end or lever *Y* located in the groove *Z*. The hinged cover *F* is swung down to the position shown, where it grips the round portion *H* of the work. The nut *J* of the eyebolt *K* which is pivoted to pin *L* is tightened in order to clamp the work securely in place. In using this fixture, it is merely necessary to swing the hinged cover back after the eyebolt *K* is swung far enough to the right to clear the slot in the hinged cover.

* * *

CLEARANCES FOR NUTS AND BOLT HEADS

By DUNCAN GARDINER

In examining the table on page 277 of December MACHINERY, the writer finds that the dimensions *B*, as given in the table, ought to be changed in certain instances, and suggests the following dimensions:

Diameter Bolt	Dimension B	Diameter Bolt	Dimension B
5/16	11/32	1 1/8	31/32
3/4	11/16	1 1/4	1 1/16
7/8	25/32	1 3/8	1 5/32
1	7/8	1 1/2	1 1/4

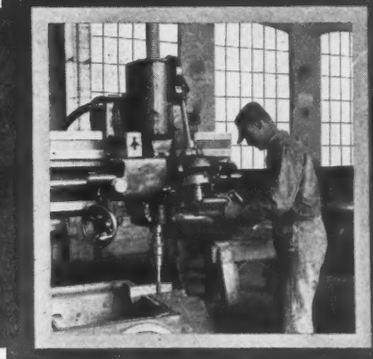
With these dimensions, the head of the bolt will be prevented from turning.

* * *

WHY WE MUST STANDARDIZE

In a paper before the American Society of Mechanical Engineers, C. F. Hirschfeld recently pointed out, in a very fair and impartial manner, both the advantages and disadvantages of standardization. He showed that standardization is an arbitrary method whereby simplification in manufacturing and distribution is obtained. The commercial tendency is to meet all the demands of the user at a considerably increased cost of production. Now the buyer, on the one hand, usually complains about costs, but still expects his special demands to be met. It is obvious that if the user expects special rather than standard equipment, he must pay the price for having his special requirements catered to. On the other hand, if he will accept a unit of which a hundred or perhaps a thousand similar units are being built on a regular manufacturing basis, he can expect a much cheaper machine. It is not a question of whether we want to standardize in our industries or not; it is a question whether we can survive commercially if we do not standardize.

Letters on Practical Subjects



EXPANSION CHUCK FOR FACING BRASS TUBES

The expansion chuck shown in the accompanying illustration is designed to permit short lengths of brass tubing to be faced off on both ends in one operation on the turret lathe. This chuck has proved very satisfactory for quantity production work on tubing 2 inches in diameter, 2⅞ inches long, with walls 0.035 inch thick, which is required to have both ends parallel and square with the outside surface within close limits. The chuck member *B* is threaded to fit the spindle of the turret lathe or screw machine. Plunger *C* is a sliding fit in the body of the chuck, and is actuated by the draw-back rod *Q*. On the outer end of this plunger and screwed tight against its shoulder is the shell *D*, which has a 30-degree taper and is hardened and ground. The sleeve *E* is split up by six slots. The alternate slots are open at one end of the sleeve and stop within 3/16 inch of the opposite end.

The sleeve *E* is hardened and ground on the tapered or angular surfaces, and the outside is also accurately ground to fit the brass tubing which is to be faced. The levers *F* are pivoted on pins *G*, and are raised by the sliding cams *H* which are fastened by a lock-nut *I* to holder *J*. The key *K* keeps plunger *C* and shell *D* in position, and allows cams *H* to slide freely.

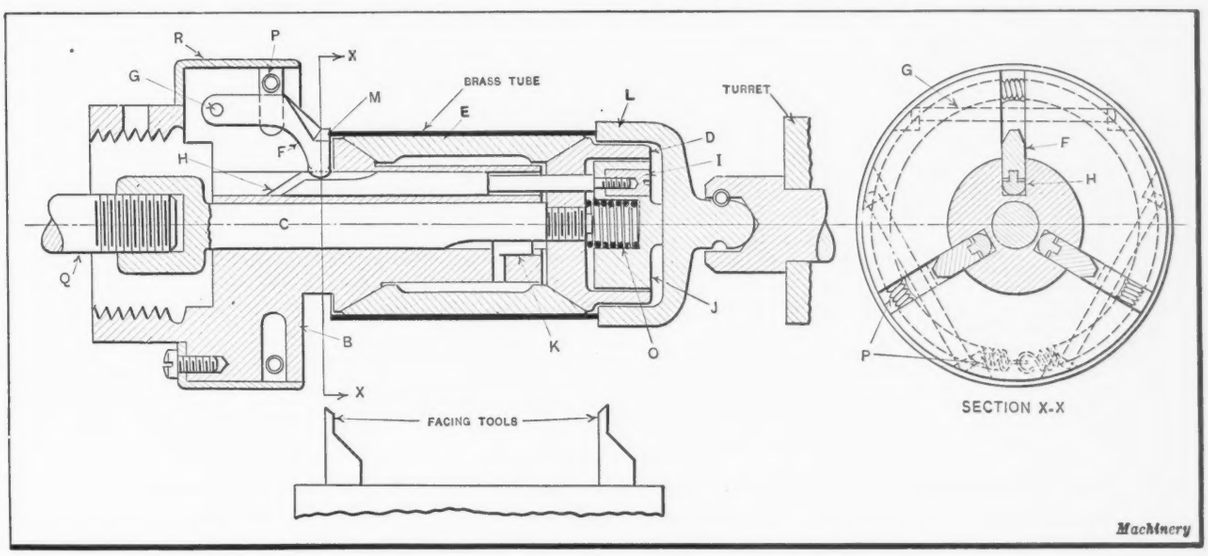
The complete chuck rotates with the machine spindle. The brass tubing, which is roughly cut 1/16 inch oversize, is slipped over the sleeve about ¾ of its full length. The shell *L*, mounted on the turret, is then pressed against the center of holder *J*, thereby moving the sliding cams *H* forward and raising levers *F* to their locating position. This operation causes the brass tubing to be carried forward into contact with the edges *M* of levers *F*, which act as stops. With the turret still exerting pressure on holder *J*, the plunger *C* is pulled in by draw-back rod *Q* of the machine. This forces shell *D* against the tapered or conical surfaces at the right-hand end of sleeve *E* and the other end against the conical or tapered surfaces of the chuck member *B*. The sleeve *E* is thus expanded so that it holds the brass tubing securely in place.

When the turret is brought back, spring *O* forces the sliding cams *H* back, allowing levers *F* to drop down through the action of the tension springs *P* which are wound around the levers and rest in grooves cut in the chuck body. The two facing tools on the cross-slide are fed against the tubing so that they cut away the surplus metal and leave the ends square with the body. The finished work is withdrawn while the spindle is in motion, and the same operation is repeated on a new piece of work. Shell *R* prevents levers *F* and springs *P* from being thrown out from the chuck body by centrifugal force.

Yonkers, N. Y. N. HORN

LEAD COMPENSATING ATTACHMENT FOR LATHE

The thread lead compensating attachment here illustrated is designed so that it can be adjusted or set to produce any variation desired in the pitch or lead of the thread being cut. It may be used to correct errors in a master lead-screw which is either too long or too short in its lead by a very small amount. It is also used to change the pitch a sufficient amount to compensate for the shrinkage or elongation that occurs when threaded work, such as taps, dies, thread



Chuck used in facing Both Ends of Tube in One Operation on the Turret Lathe

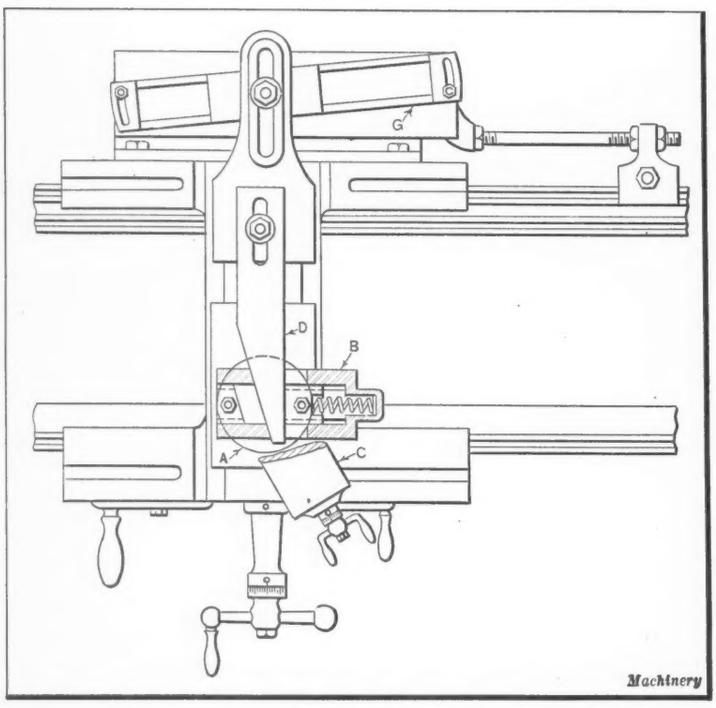


Fig. 1. Plan View of Thread Lead Compensating Attachment

gages, etc., is hardened. Again, the compensating device may be used for cutting threads of any pitch within the maximum and minimum range of the gear-change equipment, whether the thread is metric or some special form. This last field of usefulness, however, calls for an attachment having a wider range of adjustment than that provided by the usual type of thread lead compensating device.

The construction of the attachment described in the following does not call for any complicated castings or parts. Its operation is so simple that anyone having a fair degree of mechanical knowledge and skill can obtain accurate results. By employing a differential wedge action on a sub-slide, which is placed on the regular cross-slide of the lathe beneath the compound rest, it is possible to increase or decrease the distance through which the thread-cutting tool travels per revolution of the work. The variation is uniform throughout the travel of the carriage and the device can be used with the lathe set for either a forward or backward travel of the tool. The action is obtained by coupling the compensating attachment to the lathe taper attachment, as shown in Figs. 1 and 2. The various parts referred to are indicated by the same reference letters in all three illustrations.

The sub-slide bottom casting *A* is bolted to the cross-slide of the table in a position parallel to the shears of the lathe. The upper member *B* of the sub-slide carries on its top surface the regular compound rest *C*, which can be set in any angle or position desired. Operating in a slotted portion of each of the sub-slide castings is the steel differential wedge *D* having a taper of 3 inches per foot. The straight side of the wedge is always in contact with the straight side of the slot in the lower sub-slide casting at point *e*, Fig. 3, while the tapered side engages the tapered side of the slot in the upper slide casting at the two points *f*.

By providing suitable clearance space, the wedge *D* is permitted to slide or travel within the full range of its tapered section. A wedge having a taper of 3 inches per foot gives a differential action of 4 to 1. In other words, when the wedge travels either in or out a distance of 1 inch the sub-slide *B* travels ¼ inch in a direction at right angles to that in which the wedge moves. An in or out motion of the wedge is obtained by linking the wedge to the taper attachment of the lathe, as shown in Figs. 1 and 2. When the taper attachment is set to any given taper per foot, it will cause the wedge to travel in or out a corresponding distance. As the taper attachment can be set to give the wedge *D* either an inward or outward movement, it will be seen that the lead may be increased or decreased as desired.

If it is found by employing a test piece that the shrinkage in a long tap, for instance, amounts to 0.005 inch per inch, the following method would be employed in setting the attachment to compensate for the shrinkage. Only one formula is required for all applications, as follows: The angle at which the taper attachment is set in inches per foot equals the amount per inch that the lead of the thread is to be increased or decreased times 4 times 12. All settings of the taper attachment must be made with micrometer accuracy. In the example, the required increase in the lead is 0.005 inch per each standard inch of carriage travel. Using the given formula, we have $0.005 \times 4 \times 12 = 0.24$ inch, which is the taper per foot to which the taper bar *G*, Fig. 1, must be set to obtain an increase in the lead of 0.005 inch per inch of thread.

When the attachment is set as described and the lathe is set to cut the standard thread, the sub-slide *B*, Fig. 2, which carries the threading tool will be advanced just 0.005 inch per each inch of carriage travel, thereby making the required compensation in a truly proportional manner; or, in other words, the increase in the lead is uniform throughout the whole length of the threaded part. Elongation of a test piece would call for a reversal of the operation, and the standard inch of the carriage movement would have to be modified by a negative movement of the slide *B*, Fig. 2, which would be produced by having the taper attachment inclined in the opposite direction so as to withdraw the wedge bar *D* during the forward or thread-cutting movement of the lathe carriage.

The lead compensating attachment can be employed as described in the following to cut metric pitch threads on a standard geared thread-cutting lathe. As an example, let it be required to cut a 3-millimeter thread. The pitch of this thread is 0.11811 inch. As 0.11811 is contained in 1 eight times with a remainder of 0.05512, the lathe is geared up to cut eight threads per inch and the amount 0.05512 is subtracted from each standard inch of carriage travel by employing the compensating attachment. Using the formula previously given, we have $0.05512 \times 4 \times 12 = 2.6457$ inches

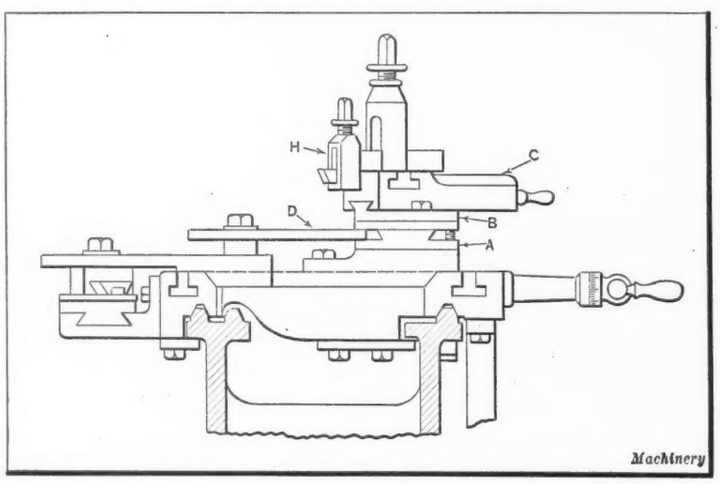


Fig. 2. Elevation View of Attachment shown in Fig. 1

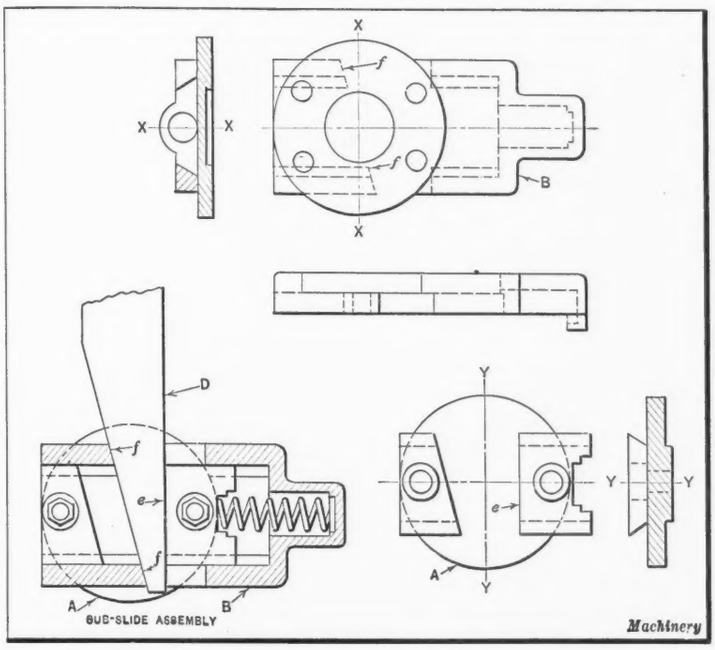


Fig. 3. Assembly and Detail Views of Parts used in Attachment shown in Figs. 1 and 2

as the amount per foot to which the taper attachment must be set.

In case it is preferable to work out the setting for cutting the 3-millimeter thread with a negative movement of the wedge, multiply the pitch by 9 and subtract 1, which equals 0.06299 inch. Therefore with the carriage geared to cut 9 threads per inch, a negative movement of 0.06299 inch must be provided for; or in other words the taper attachment must be set to decrease the pitch an amount equal to 0.06299 per inch. Any odd or fractional thread can be cut in a similar manner by either the increment or decrement method with the lathe geared to cut the nearest standard thread. The interposing of the slides between the lathe cross-slide and the compound rest necessitates the use of a drop or underhung tool-holder such as shown at *H*, Fig. 2.

Allentown, Pa. JOE V. ROMIG

ALIGNING VISE JAWS

One of the most abused and yet one of the most important tools in any machine shop is the vise. It seems strange to the writer that this tool does not receive more attention. Seldom does the screw or thrust column receive any oil, despite the fact that an oil-can is always at hand on the bench. The vise jaws should be parallel with each other, both in a vertical and a horizontal plane. The jaws of all the vises used in the tool- and die-room should be ground, except the larger sizes which are used for very heavy work.

In grinding the vise jaws, it is well first to clamp a block or plate inside the lower portion of the jaws, so that all play will be taken up and the jaws ground while under a clamping strain such as they would be subjected to when holding a piece of work. The vise, with the plate clamped in place, should be removed from its base and placed on the table of a tool or surface grinder. A saucer-shaped grinding wheel should be used, and after one jaw has been ground smooth or to a true surface, the wheel should be reversed on its spindle and the face of the opposite jaw ground without moving the vise.

After the jaws have been ground in this way, the vise should again be fastened to its base and a long straight "parallel" clamped in the jaws. The base should then be shimmed up until the parallel is in a vertical position, after which the base is bolted tightly to the bench. With the faces of the vise jaws accurately lined up in this manner, more accurate work can be done when filing.

Ontario, Cal. CHARLES HOMEWOOD

HOLDING SPLIT BUSHINGS WHILE BORING

The turning and boring of split bronze bushings is often accomplished with difficulty because of the trouble experienced in holding the planed halves securely together in the chuck jaws. The usual method is to sweat the halves together or secure them with some kind of clamp. An inexpensive and simple way to overcome this difficulty—where access to an electric welding outfit is to be had—is to clamp the planed halves together with C-clamps and weld across the joint on each end of the bushing. This allows the bushing to be bored and turned as if it were a solid cylinder. One end is then faced off, which removes the weld. The bushing is then turned end for end in the chuck and clamped across the split end while the other end is faced. This finishes the operation and leaves the bushing in halves.

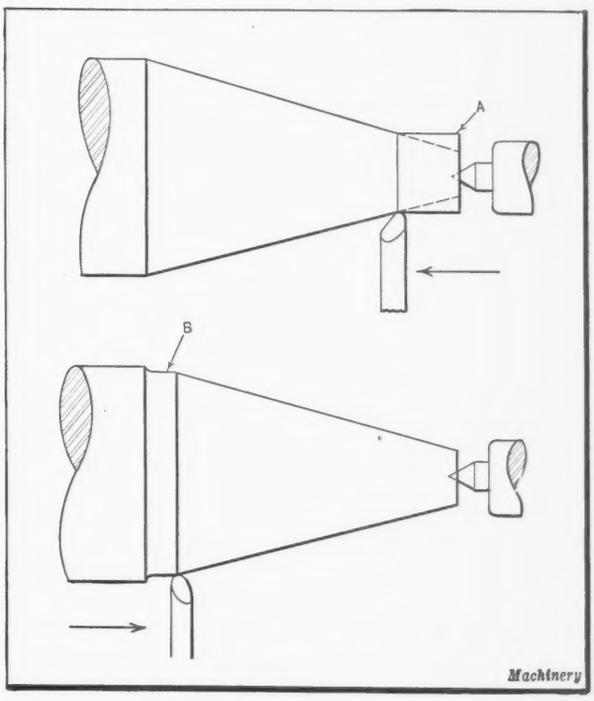
York, Pa. P. J. REES

TURNING TAPERS

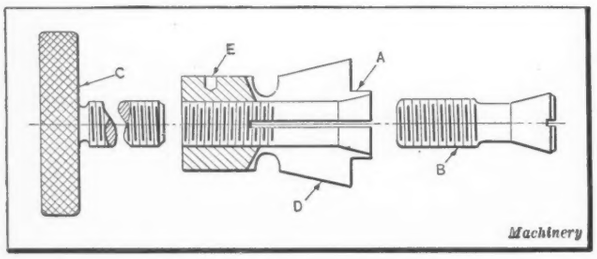
In turning tapers on a lathe with a taper attachment, difficulty can sometimes be avoided by having the tool travel from the large to the small end of the work. When the tool starts to cut at the small end, it will travel along a path parallel to the center of the work until the lost motion between the shoe and the rail and other joints in the taper attachment is taken up. The result will be a short cylindrical section at the small end of the work, as shown in the upper view in the illustration.

If a taper sleeve is tried on the work to test the part, it will bear on the end of this cylindrical section at *A* and the lathe operator will be led to believe that the machine is not adjusted to turn as steep a taper as required. When the cut is started at the large end of the work, a short section will also be turned cylindrical as shown at *B* in the lower view, but this cylindrical part will not interfere with the gaging of the taper. When the lost motion in the taper attachment is once taken up, the tool will be drawn by a positive movement toward the center of the work until the end of the piece is reached.

Cleveland, Ohio EDWARD HELLER



Diagrams showing how Direction of Tool Feed affects Work



Special Collet for holding Thin Cutters

COLLET FOR USE IN FACE-GRINDING THIN CUTTERS

The accompanying illustration shows the disassembled parts of an expansion collet for grinder use, which is especially adapted for face-grinding thin cutters. The straight part of the collet is a slide fit in the spindle, and the taper end is expanded in a corresponding taper chamber within the spindle. The cutter to be ground is first gripped on the end *A* of the collet by means of the expanding screw *B*, which has a screwdriver slot in its head. The collet is then drawn back against the faceplate of the spindle by means of the knurled screw *C* which passes through the grinder spindle, until the tapered section *D* engages the corresponding tapered section of the spindle.

The collet should be made so that the large end will draw slightly within the spindle to insure that the cutter will bear against the faceplate. Split bushings may be provided for cutters having larger holes than the end diameter of the collet. A pin is set in the straight part of the collet at *E* to prevent it from turning in the spindle when tightening either the screws *B* or *C*.

Springfield, Vt. O. S. MARSHALL

TRUING UP PLANER WAYS

In reconditioning three small planers it was found necessary to take a cut on the vees of the tables and also on the ways of the beds. The distance between the rack on the table and the shaft of the driving gear was thus shortened a distance of about 3/32 inch. The next problem was to make the rack and the driving gear mesh properly. The rack on the planer was cast integral with the bed and, of course, could not be removed to take a cut on the back side. It was at first planned to have a special gear designed to meet the new conditions, although it seemed a considerable waste to replace three gears by new ones which could not be expected to run or mesh with the old rack nearly as well as the old ones.

The making of new gears, however, was avoided, as it was found that the driving gear was mounted on an idle shaft supported by two cast-iron bushings driven into the planer bed. The method employed was to make eccentric bushings for the driving gear shaft. By turning or adjusting these bushings the distance between the rack and the gear could be increased so that the gear would mesh properly with the rack. The eccentricity or offset between the hole and the outside diameter of the bushing was approximately ⅛ inch. Since reconditioning the three planers, the same method of remeshing driving gears with their racks has been successfully employed for other types of machine tools after truing up their ways.

Rockford, Ill. RALPH BILLINGHAM

EQUIPMENT FOR PLANING DRIVING-BOX SHOES

In Fig. 1 is shown a planer set up for planing sixteen or more driving-box shoes in one operation without resetting. One of the clamping blocks *A* is shown in detail in Fig. 2. These blocks are made from machine steel, and the sharp-angled edges that grip the work are casehardened. The clamping blocks are fastened to the planer table by means of T-bolts *B* and steel rods *C*, Fig. 2. The rod *C* passes through all the clamping blocks and extends the entire length of the planer table.

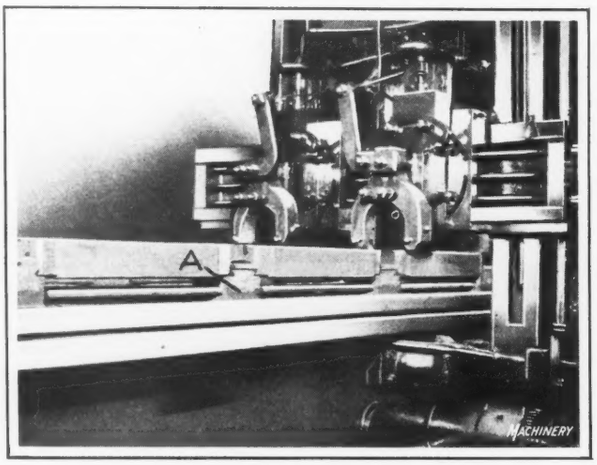


Fig. 1. Planing Sixteen Driving-box Shoes in One Set-up

Tool-holders of an inverted U-shape are used for the planing operation. Air hoists are attached to the tool-holders, which raise them at the end of each forward stroke of the planer and keep them in the raised position until the planer table again begins its forward cutting stroke. This avoids dragging the cutting edges of the tools over the work on the return stroke of the table. A three-way air valve is connected with the pipes that lead to the air cylinder in a convenient operating position near the reverse levers, and is connected with the reversing levers of the planer so that the air hoists are operated automatically.

St. Elmo, Tenn. H. H. HENSON

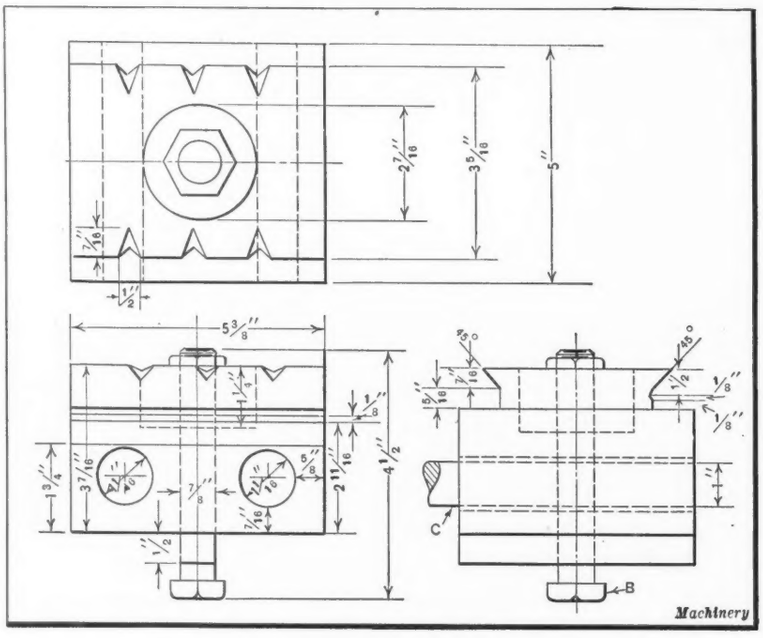


Fig. 2. Details of Clamping Block shown at A, Fig. 1

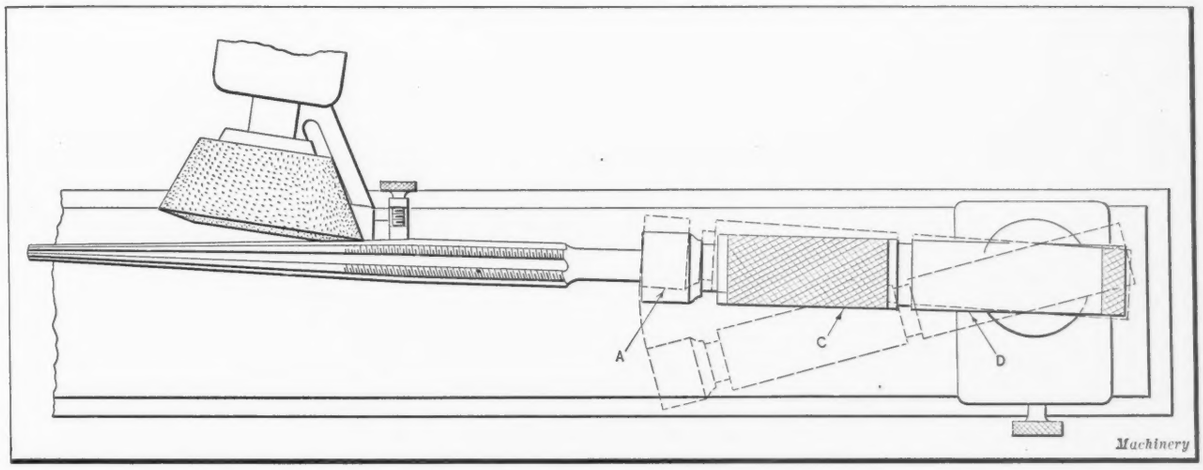


Fig. 1. Plan View of Staybolt Tap Grinding Fixture

FILING AND NUMBERING SYSTEM FOR THE DRAFTING-ROOM

The method of filing and numbering drawings described in the following has proved very satisfactory for lay-out, sub lay-out, and detail drawings. In this system, each detail drawing is given a part number, and these drawings are filed in numerical order, and according to the size of the drawing sheet. One master lay-out is usually made for each machine, which is given a letter or combination of letters such as *A*, *M*, *AB*, etc. Every sub lay-out of each machine should contain the characteristic letter of the master lay-out followed by the number of the particular sub lay-out such as *A-1*, *A-26*, *CA-24*, etc. A card index is kept which contains a properly filled out card for each detail, sub lay-out, and master lay-out drawing. The card corresponding to the master lay-out of each machine is placed just in front of the cards representing the sub lay-out numbers for that particular machine, and these, in turn, are followed by the detail cards, which are filed in numerical order.

If a part is interchangeable or is used on a number of different machines, an index card is filled out for each machine on which the part is used. The index cards for the details contain the part number, the size of the drawing, the name of the part, the kind of material from which it is made, and in many instances, the size. Space is generally provided for writing in any special information or remarks regarding the part. The index cards, however, may be made up to suit the particular requirements of the manufacturer. It is a good plan to keep a complete list of the part numbers, lay-outs, sub lay-outs, and details in a loose-leaf note book. Such a list facilitates the issuing of new part numbers and is a source of useful information.

Lansing, Mich. C. F. Powers

GRINDING FIXTURE FOR STAYBOLT TAPS AND TAPER BRIDGE REAMERS

Staybolt taps are probably subjected to more severe usage than any other kind of tap. They are run at high speeds, and are required to produce smooth full threads in boiler plate, therefore requiring resharpening frequently. In railroad shops the usual method of sharpening staybolt taps is to grind the lands on the tapered cutting section of the tap by hand on an open grinding wheel or on the tool-grinder. The object in designing the fixture shown in Figs. 1 and 2 was to provide a more accurate means for the rapid grinding of staybolt taps and taper bridge reamers. This fixture can also be used to good advantage in grinding taper bridge reamers that have no center at the small end.

The staybolt tap to be ground is inserted in the chuck *A*, and the tooth-rest *B*, Figs. 2 and 3, is adjusted to give the cutting edge the correct amount of clearance or relief. The table is adjusted transversely to bring the tapered section of the tap parallel with the table slide, as shown in Fig. 1. The tap is held against the stop by the operator while the table is fed back and forth by means of the regular feeding

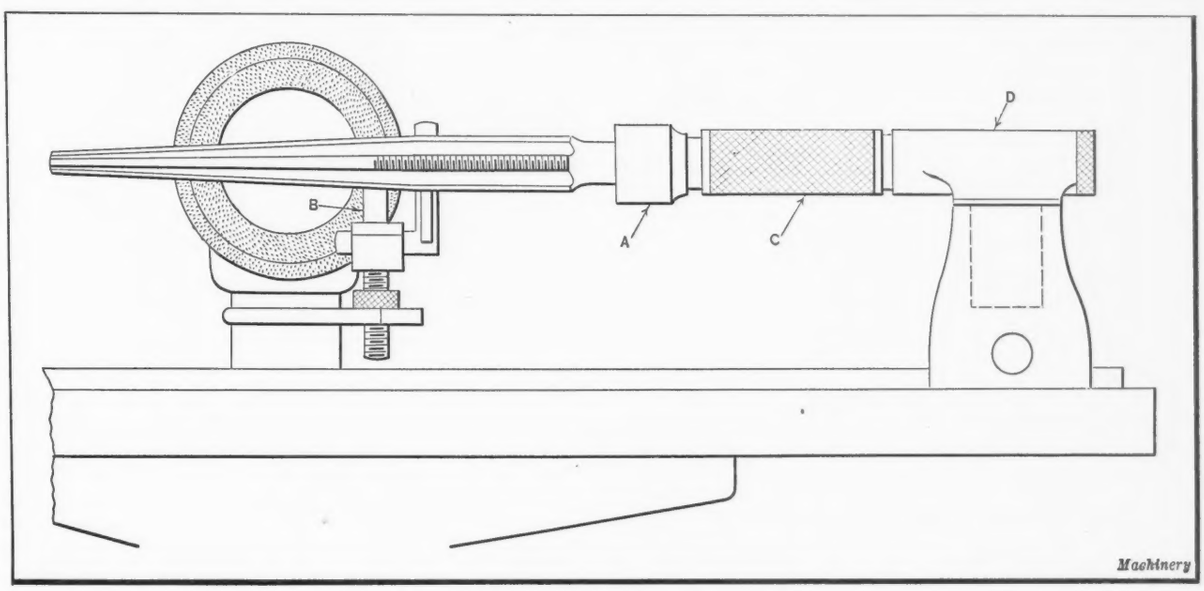


Fig. 2. Elevation View of Fixture shown in Fig. 1

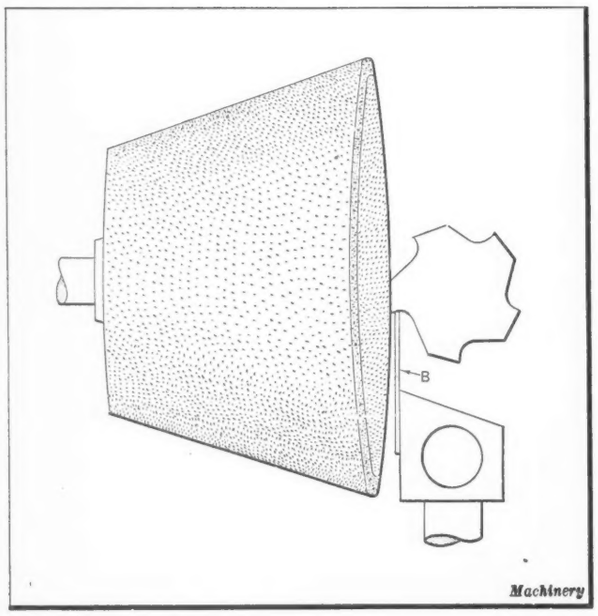


Fig. 3. Method of using Cup-wheel

mechanism. In grinding tapered bridge reamers, a Morse taper socket is substituted for the chuck. The depth of the grinding cut is regulated by the stop attached to the tooth-rest, which provides sufficient support to prevent the work from chattering. Either straight or spiral fluted taps or reamers may be ground on this fixture, as the handle *C* can be turned within the body *D*.

Sedalia, Mo. W. M. HAYES

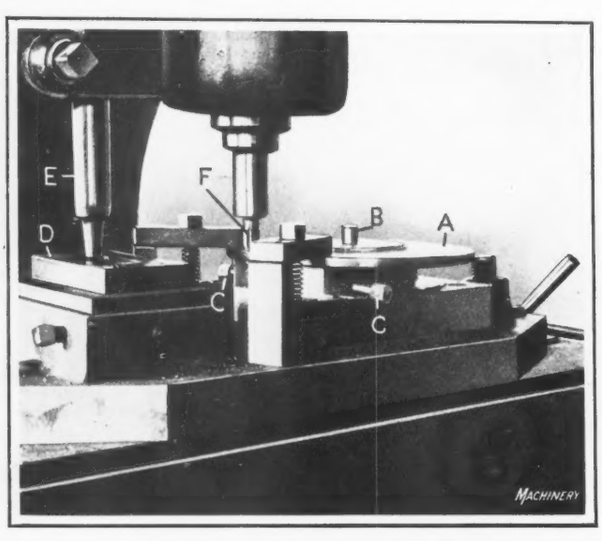
FIXTURE FOR PROFILING TRANSIT PLATES

Transit plates for surveying instruments, such as shown at *A* in the illustration, are machined with a slot about 1½ inches long by ⅝ inch wide, the outer section being made slightly larger than ⅝ inch for a depth of ⅛ inch. This slot receives the vernier glass which rests firmly on the ledge formed in the slot. The machining of the slot is performed with the set-up shown in the illustration. The plate *A* is located by means of the pin *B*, which fits into a reamed center hole in the piece.

The screws *C*, one fixed and the other adjustable, bear against ribs on the plate casting, and locate the work so that the profile slot will be in the correct position. It might be mentioned here that the ribs against which the screws *C* bear were also used in locating the plate for the previous machining of the center hole, thus insuring the accurate positioning of the slot with respect to the center hole.

The forming plate or templet *D* and the pin *E* control the movement of the cutter and work, and determine the shape or profile of the slot which is milled in the plate. When pin *E* is in contact with the former opening in templet *D*, the cutter *F* (which is made with two sections of different diameters in order to form the special shape of slot previously described) will be in the correct position for profiling the slot in the plate.

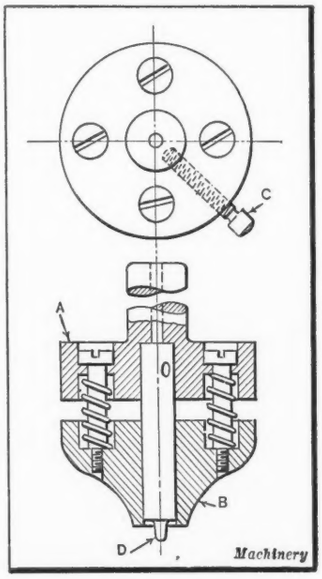
Providence, R. I. ROBERT MAWSON



Set-up for milling Slots in a Transit Plate

RIVETING PUNCH WITH SPRING SHEDDER

When using a plain pilot-punch for staking or riveting bushings in small machine parts with a power or foot press, the bushing often fails to seat properly, so that a gap is left between the part and the body of the bushing. The style of punch shown in the accompanying illustration has the advantage of holding the parts firmly in place while riveting, and also prevents them from sticking to the punch. The body *A* and shedder *B* are turned from cold-rolled or machine steel. The shedder should be pack-hardened to prevent the lower end from being worn away too rapidly. The shank is turned to fit the hole in the press ram or punch-holder, and other dimensions may be varied to suit individual conditions.



Riveting Punch provided with Spring Shedder

The four fillister-head screws are made a sliding fit in the body. Three screws may be used if preferred. A stiff open-coiled spring is placed around each screw in the counter-bored pockets, and if more tension is required, additional spring pockets can be provided between the screw-holes. For this reason it is best to try out the tool before hardening any part of it except punch *D*.

The riveting punch (usually made of drill rod) is a tight fit in the body, and is held in place by a set-screw *C*. A small hole drilled through the center of the shank allows the punch to be driven out when the screw is loosened. The shedder is a sliding fit on the punch. Assembling and disassembling can be easily done by holding the punch in a vise with the end of the shank against the front jaw and a collar on the shedder nose against the back jaw. Any small collar having a hole slightly larger than the pilot of the punch will do, for it is used simply to permit the springs to be compressed without having the pilot come in contact with the vise jaw.

In actual practice, the bushing to be riveted is placed in a suitable nest or pocket in the die-block, directly under the riveting punch, and the machine part is placed on the bushing, the hole in the part being a close but not a driving fit. When the press is operated, the shedder snaps the part down tightly on the bushing, holding it there until riveted, and preventing it from being lifted by the pilot, which, of course, fits the hole closely after riveting.

This device is not limited to the riveting of bushings, for with a star-pointed punch in place of the pilot-punch it is useful for riveting solid studs where smoothness is not essential. However, by drilling a shallow hole in the end of the stud to be riveted, a short pilot may be used and a smooth eyelet effect produced.

West Hartford, Conn. ERNEST L. HOLCOMB

Shop and Drafting-room Kinks

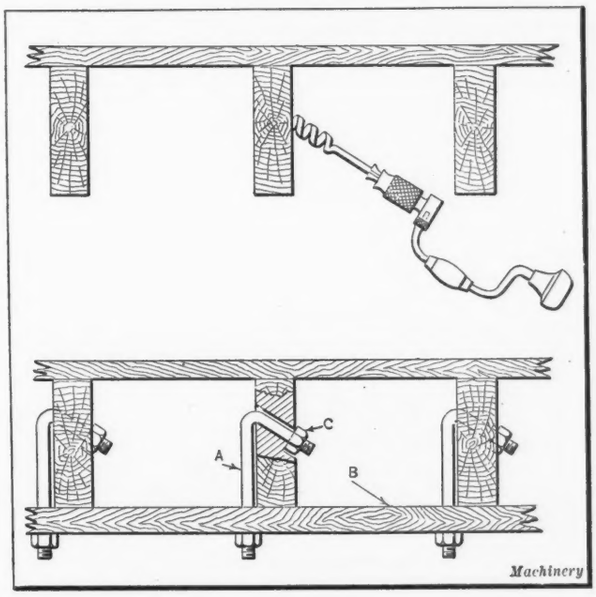
REPAIRING A BROKEN LINESHAFT

A 2-inch lineshaft that broke at a very inopportune time was quickly and successfully repaired in the following manner: A 2-inch pipe, 4 feet long, was slipped over one end of the broken shaft, after which the shaft ends were brought together and the pipe pulled back over the break so that the broken ends would be in the center of the pipe. The pipe was then secured to the broken ends of the shaft by ½-inch rivets inserted in holes drilled through the pipe and the shaft.

Denver, Col. R. M. THOMAS

METHOD OF SECURING OVERHEAD TIMBERS

The method shown in the accompanying illustration for securing timbers that are to carry countershafts or other overhead equipment has some advantages over the methods



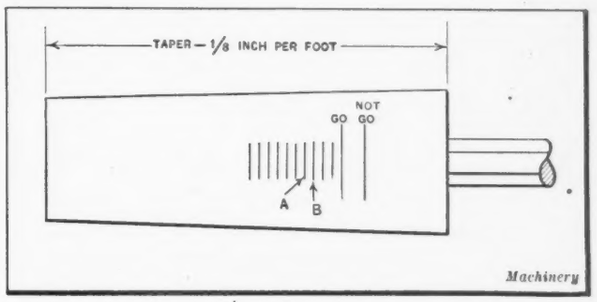
Method of putting up Timbers for Overhead Equipment

usually employed. When floor timbers are placed close together, it is difficult to bore a hole transversely through the timbers with an ordinary bit brace, but it is comparatively easy to bore a hole through the timber at an angle, using a ratchet brace, as indicated in the upper view.

The bolts *A* used to secure the piece *B* are bent at an angle, as shown, and if made the proper size need not be fitted with nuts *C*. In most cases, however, it is best to provide the bolts with nuts so that they will be kept from pulling out in case they are straightened by being subjected to undue stresses. M. W. S.

TEST GAGE FOR GRINDING HOLES

When round holes are to be ground accurately to size, it is convenient to have some means of determining not only when the hole has been enlarged to the correct size—an ordinary gage will indicate this—but also how much metal must be removed before this is accomplished. In the accompanying illustration is shown a gage designed for this



Test Gage for Internal Grinding

purpose. The gage is round with a taper of ⅛ inch per foot, so that the graduations at *A*, each of which indicates a difference of 0.001 inch in the diameter of the hole, are spaced about 0.1 inch apart. At any stage of the grinding operation, this gage can be inserted in the hole and will show how much metal must be removed. For instance, if the gage can be inserted only as far as the graduation indicated at *B*, the operator knows instantly that approximately 0.003 inch must be removed before the "Go" limit is reached.

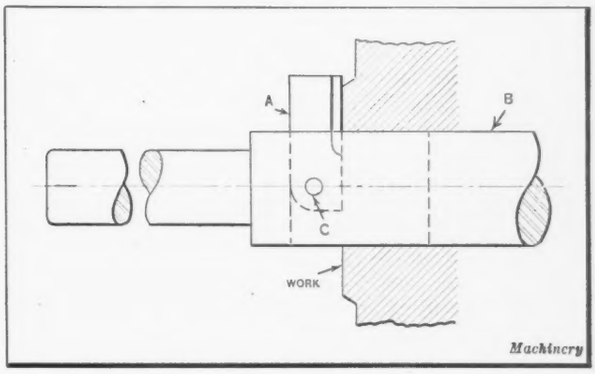
Bridgeport, Conn. D. W. MCCROSKY

BACK-FACING TOOL

A tool of rigid construction, which has proved a time-saver when used in a turret lathe for back-facing the hubs of gears, sheaves, pulleys, and similar parts, is shown in the accompanying illustration. The cutter *A* is fitted into a slot in a piloted bar *B* and can be pivoted on pin *C* so that it lies entirely within the slot in the bar. When the cutter is folded down, the bar can be inserted through the hole in the part to be back-faced, after which it can be raised up into the position shown and fed into contact with the work.

The cutter is made long enough to cover the face of the hub as shown. When there is considerable stock to be removed, a roughing and a finishing cutter can be employed, the changing of cutters being accomplished by driving out the pin *C*. The pressure on the tool is carried by the back face of the slot in the boring-bar. A tool of the type described, which was mounted in a 3½-inch bar having a 3-inch pilot, has been used successfully by the writer for facing a hub 7 inches in diameter. The cutter used for this work was ¾ inch thick by 2 inches wide. A ¾-inch pivot pin was used.

Evansville, Ind. A. HUNT



Piloted Back-facing Tool for Turret Lathe

The Machine-building Industries

EVERY indication is that the present year will be as nearly a "normal" year in industry as we have seen for the last ten years. There is no boom in sight, nor are there any signs of a business depression. It is a presidential election year, but there are no great issues upon which public opinion varies to any considerable extent, and there is no reason why the election should have any material effect upon business conditions. If Congress passes a new income tax bill with reasonable tax reductions, and particularly if modifications are made in the present iniquitous methods of levying taxes upon business enterprises, industrial activity would be encouraged to a much greater extent than it is likely to be slowed down because of election uncertainties.

Furthermore, if there is no adverse railroad legislation, so that the railroads can continue their constructive program of building up an adequate transportation system—a program which has been constantly followed during the last two years—there is every reason to believe that the present year in most lines of business will equal or surpass 1923.

The year starts under favorable conditions. The production of pig iron and steel ingots—the unfailing indicator of industrial activity—is increasing. The Federal Reserve Board's index of factory employment shows that at the end of 1923 the number of people engaged in the industries was only 4 per cent lower than at the peak period last spring when we experienced a definite business boom. The largest decreases in employment were in plants manufacturing food products, which is a seasonal industry, and in railroad equipment plants, the activity of which was somewhat reduced after the great demands placed upon them during the preceding eighteen months. Building contracts at the end of the year showed an increase of 25 per cent over a year ago. Business generally has started off this year with more confidence than it had a year ago.

During the past month the editor of MACHINERY has visited nearly one hundred machine-building plants manufacturing not only machine tools, special machinery, small tools, and other shop equipment, but many other classes of industrial machinery—electric generators and motors, steam turbines, pumps and pumping engines, gas engines, general power plant equipment, hydraulic turbines, locomotives, woodworking machinery, textile machinery, excavating and road machinery, and automobiles. Of these industries, depending upon the machine tool industry for their equipment, nearly all are exceptionally well employed, the only branches in which there is temporarily a lessened activity being the locomotive field, the textile machinery shops, and the small gas engine plants. Most of the other shops are running to capacity, especially in the power plant machinery and the electrical industries.

The Machine Tool Industry

Renewed activity in the machine tool field reflects general confidence in the industrial situation. The new orders placed with machine tool builders in January showed a considerable increase over December. Shops engaged in the building of high-production and special machine tools are well employed, some running to capacity. Those engaged in building what are termed "standard" machine tools are not fully occupied, because the total machine tool building capacity of the country still exceeds the normal demand. Most of the leaders in the field and many of the smaller shops, however, average about 60 per cent of capacity, doing a total business which is considered "normal" by many.

It is quite evident that buyers are more and more adopting a new attitude toward the buying of machine shop equipment. They are no longer merely buying machine tools; they are buying production and decreased cost of output. The more completely machine tool builders meet this demand, the more fully do we find their shops occupied. Some of the leaders in the industry point out that the pre-war type of machine tool, generally speaking, is obsolete for heavy production. It is the advanced type that sells, and there never was a time when it was more necessary than now for machine tool builders to bring out improved designs in order to meet the severe competition of the special machine.

The automobile plants continue to be the most important customers of the machine tool industry. In the Detroit district, especially, dealers state that 1923 was a banner year, and that the early part of 1924 promises at least to equal, if not surpass, the past year.

The demand for small power presses is unusually active due to the increased demand for stampings. In Michigan and Ohio, especially, the stamping shops work to capacity, some working night shifts. This unusual activity is due not only to demands from the automobile industry, but also to the constantly increasing demand for pressed-steel parts from other industries.

The railroads have placed a fair number of orders, but on the whole they are deferring buying until they know quite definitely whether any adverse legislation affecting their revenues is likely to be passed by Congress. Last year the railroads bought an unusually large amount of rolling stock, so that large quantities of that class of equipment will not be required this year, and it is likely that the railroads will now be in a position to place substantial orders for shop equipment. In fact, greater shop facilities will be necessary in order to keep the increased rolling stock in good operating condition.

The Automobile Industry

At no previous time has the automobile industry maintained so nearly capacity production during the winter months as this year. Some of the leaders in the field have continued to produce at full capacity throughout what is ordinarily the slack season. The consensus of opinion is that the output for 1924 will be approximately 3,500,000 cars, but the announced expectations of individual companies total more than 5,500,000 cars, indicating severe competition and continued low prices during the year. Doubtless some of the weaker companies will be forced to drop out. Practically every month brings news of some one builder of automobiles passing out of existence.

The Iron and Steel Industry

Improved conditions in the iron and steel market promise renewed activity in the entire machine-building field. While there is no sudden boom in the steel industry, as might be inferred from some of the more optimistic reports, there is a very steady and gradual improvement. The U. S. Steel Corporation is now operating at about 90 per cent of capacity, and the independent companies range from 75 to 90 per cent. Final consumption has not grown in proportion to these increases in mill activities, and stocks are probably being accumulated against a possible coal strike, so that pig iron and ingots may be available as a source of supply for the finishing mills. Both the pig iron and steel markets are sufficiently active to advance prices slowly. The trend of prices will probably be upward for some time to come, and it is likely that buyers of pig iron and steel would make no mistake if they covered their requirements for the next six months.

New Machinery and Tools

The Complete Monthly Record of New Metal-working Machinery

Sommer & Adams Rotary Spline Hobbing Machine

ONE of the remarkable things about the machine tool industry is the large number of machines of entirely new design that are constantly being placed on the market. A recent addition to this class of machines is the multiple-spindle spline hobbing machine built by the Sommer & Adams Co., 18511 Euclid Ave., Cleveland, Ohio. In this machine eight pieces of work are finished by as many hobs, while practically the entire machine, with the exception of the base, revolves past the operator. The machine has been designed primarily for hobbing splines on one end of automobile axle shafts, but it is adaptable to other kinds of work, and it is believed that the same principles could be applied to the hobbing of gears. On the basis of one revolution of the machine every four minutes, a production amounting to 1080 pieces per nine-hour day—one piece every 30 seconds—can be obtained; however, it is said that the machine can easily be run at a faster rate of speed with increased production.

General Features of Construction

Attention is called particularly to the compact design, there being eight distinct units spaced equidistantly around the machine. Each unit consists of a work-head, a cutter-head, and mechanisms for driving both. The cutter-head *A* (Fig. 1) and the work-head *B* of each unit are attached to the outside of an upright turret, which rotates constantly around the base, on which it is held in a central position by means of a generously proportioned upright column casting at the center of the machine.

The machine is driven by a 7½-horsepower constant-speed motor running at 1200 revolutions per minute, which is connected direct through spur gears. The driving shaft runs through the machine to gear-box *C*, in which there is a pair of slip change-gears. From this gear-box the drive is transmitted by a shaft to the inside of the turret where the horizontal shaft is equipped with a worm which drives a short vertical shaft through a worm-wheel. At the upper end of this vertical shaft there is a spur pinion which engages a ring gear extending completely around the turret, and thus rotates it. Various speeds of the turret are obtained by changing the slip gears in box *C*. The weight of the rotating parts on the base is comparatively heavy, and so special oiling devices are provided for lubricating the surface of the base on which the turret slides.

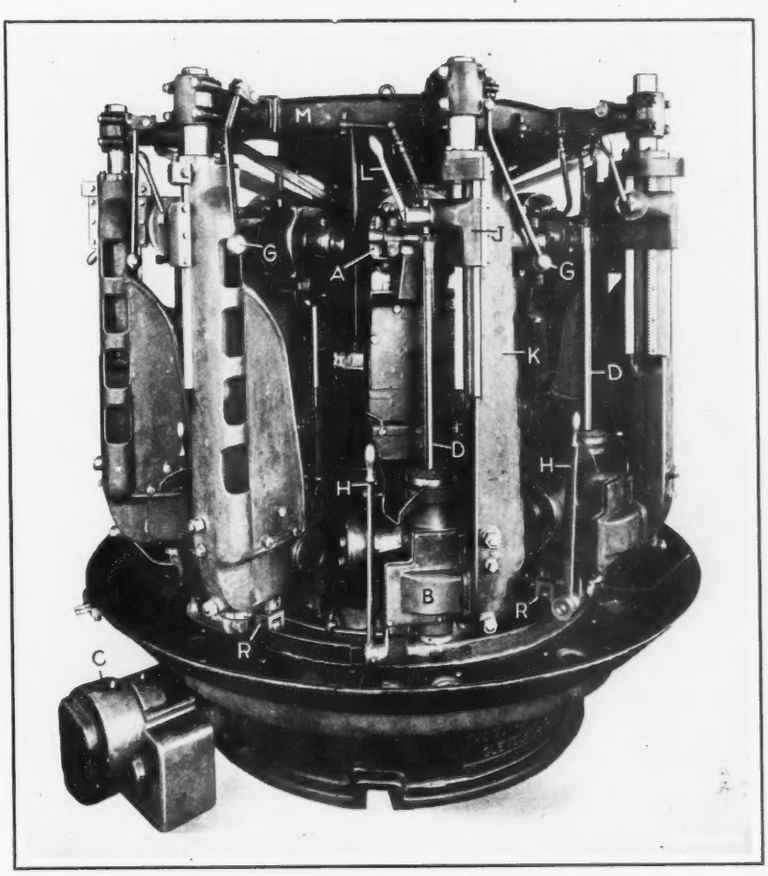


Fig. 1. Sommer & Adams Rotary-type Multiple-spindle Spline Hobbing Machine

Method of Feeding the Work

From the close-up view shown in Fig. 2, it will be seen that the work *D* is held vertically with the end to be splined uppermost, and that the hob *E* is positioned horizontally. During an operation, the work is fed the required distance past the hob by means of a cam *F*, Fig. 3, which extends completely around the base of the machine, and a roller *R* attached to the lower portion of each work-head. The chip pan was removed at the time this photograph was taken to give a better view of the cam. Each roller travels on the cam, and raises and lowers the entire work-holding assembly as the latter is carried around the base.

The cam has an abrupt drop from the highest to the lowest position, and extends at the low level *X* for a short distance, after which it rises quickly to an appreciable height and then gradually at a slow and uniform rate until the highest point is reached. When roller *R* is at the lowest position, the work is entirely withdrawn from the hob, and can be easily replaced by the operator. As the roller leaves the low position, the work is brought into contact with the hob and then fed gradually past it until the highest position is reached, at which time the operation is completed.

Power for driving both the hob and work-spindles of each unit is taken at the center of the machine from the main driving shaft through bevel gears. The drive is then transmitted by a vertical shaft, which extends to the top of the central column of the turret, to a large bevel gear. Meshing with this gear are eight bevel pinions mounted loosely on horizontal shaft radiating to each hob head, through which power is derived for rotating the hob and work-spindles. Each bevel pinion is connected to the shaft by a Carlyle-Johnson

friction clutch, controlled through handle *G*, Fig. 1. By means of the clutch, the drive to any of the eight units may be disengaged without affecting any of the others.

From this horizontal drive, the drive to the hob spindle is through slip change spur gears and bevel gears to a shaft in the same horizontal plane as the hob spindle, from which the latter is driven through bevel gearing. The bracket in which the hob spindle is held may be adjusted radially to permit setting the hob in various angular positions, and there is also a longitudinal adjustment. A screw equipped with a micrometer dial permits accurate settings to be readily made.

The Work-head Units

Power for driving the work-spindle in housing *B* is also taken from the horizontal shaft that radiates to each unit from the central bevel gear, the drive being transmitted through bevel gears and a long vertical shaft to the mechanism in housing *B*. From this vertical shaft the drive is through bevel gears, slip change spur gears and worm-gearing to the vertical work-spindle. Handle *H* is attached to a cam directly under the center of the work-spindle and operates a "knock-out" for removing the work from the spindle when completed. It will be evident that a certain ratio must always be maintained between the rotation of the hob and work-spindles; this is accomplished by means of the change-gears provided for both the hob and work-heads. In the case of a ten-spline axle shaft, the hob spindle must revolve ten times to one revolution of the work-spindle.

The lower end of the work is tapered and seats in a socket in the work-spindle, while the upper end is supported by a center mounted in the projecting end of stock *J*. This stock is mounted on a vertical arm *K*, which is bolted to the work-head housing at the bottom and rigidly supported at the top by a bearing in a bracket attached to casting *M*. The latter is mounted on the turret and rotates with it. Housing *B* may be adjusted vertically on the turret face to provide for splining axle shafts of various lengths, and there is also a vertical adjustment for stock *J*. Raising and lowering of the work-holding center is quickly accomplished when reloading, by simply manipulating handle *L*, which also serves as a binder for holding the stock firmly in position.

The main feature claimed for this machine is that a large production is obtained with a machine occupying a minimum floor space and with little handling of the product. Each unit is equipped with an individual pump for delivering coolant to the hob, the pump being driven from the vertical shaft that delivers the drive to the work-spindle. The base of the machine serves as a reservoir for all pumps. Double-row annular ball bearings are provided on practically all shafts, and thrust bearings wherever these are required. All shafts are made from carbon steel and all gears are heat-treated. The weight of the machine is about 16,000 pounds. It was designed by L. A. Sommer, president of the Sommer & Adams Co.

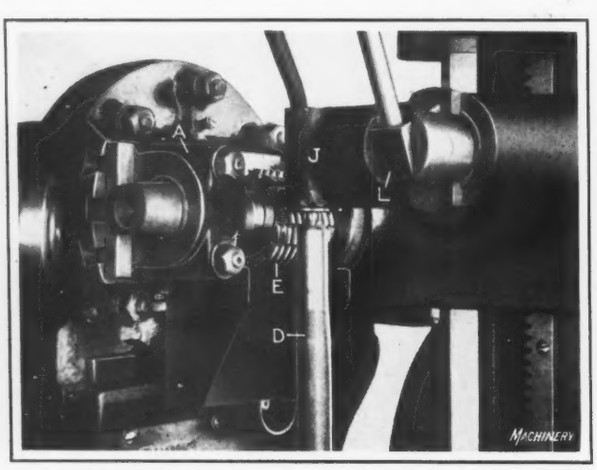


Fig. 2. Close-up View showing the Relation between the Hob and the Work

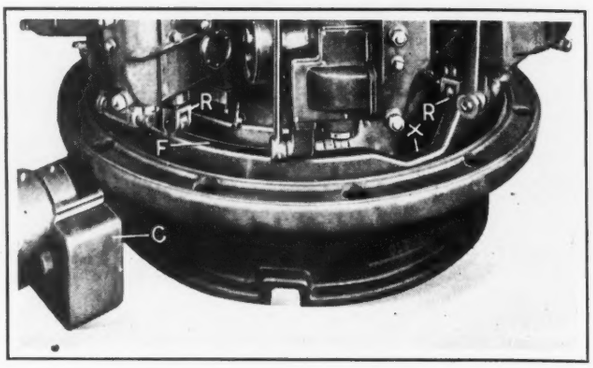


Fig. 3. View of Base with Chip-pan removed to show Work-head Feeding Cam

BAUSCH & LOMB METALLOGRAPHIC EQUIPMENT

A new metallographic equipment consisting of a large inverted microscope and a complete illuminating system mounted on a common base is being placed on the market by the Bausch & Lomb Optical Co., Rochester, N. Y. The principal reason for developing this improved equipment was to reduce as much as possible the aligning adjustments formerly necessary in operation. This GL-ILSR-9 outfit, assembled with a "V" supplementary camera, No. 4661 shock absorbers, and a supporting stand, is illustrated in Fig. 1, while Fig. 2 shows the metalloscope alone. Another type of shock absorber may also be furnished.

The main features of this equipment are as follows: A permanent alignment of the axis of the condensing lens system on the illuminating unit with the center of the vertical illuminator; the centering and setting of the vertical illuminator with reference to the vertical axis; a carrier with a clear glass reflector provided with a stop to insure its being used in a 45-degree position relative to the axis of the objective; a vertical illuminator provided with a side tube and condenser, sliding diaphragm with four apertures, and ray filter giving practically monochromatic light; a quick-changing nose-piece or clutch having three objective rings with handles to facilitate the interchange of objectives; a graduated scale on the rack-slide of the microscope which facilitates setting objectives approximately in focus on the specimen when changing from one objective to another; an illuminating system with simple adjustment, by means of which it is possible to secure photographs with a large area of flatness or with a maximum resolution of detail; a new light source, comprising a Mazda lamp having a solid strip of tungsten, this lamp providing a homogeneous and constant light source and making possible the standardization of an exposure factor; the fitting and aligning of the microscope and the illuminating unit to the common base which makes it practicable to remove these parts from the optical bench if the camera is to be used for other purposes or when it is more convenient to use the metalloscope on a table for visual observation.

The stage of the microscope is provided with a rack and pinion movement in two directions and with a circular plate that has a V-shaped slot to accommodate specimens of various sizes and shapes. The regular optical equipment consists of 16-, 8-, and 4-millimeter achromatic microscope objectives, short-mounted and corrected for use with uncovered objectives for a tube length of 215 millimeters, and one pair each of 7.5 and 12.5 "Hyperplane" eyepieces. Excellent results may be obtained with these objectives and eyepieces for magnifications up to 1000 diameters, but for greater magnifications, oil immersion objectives should be

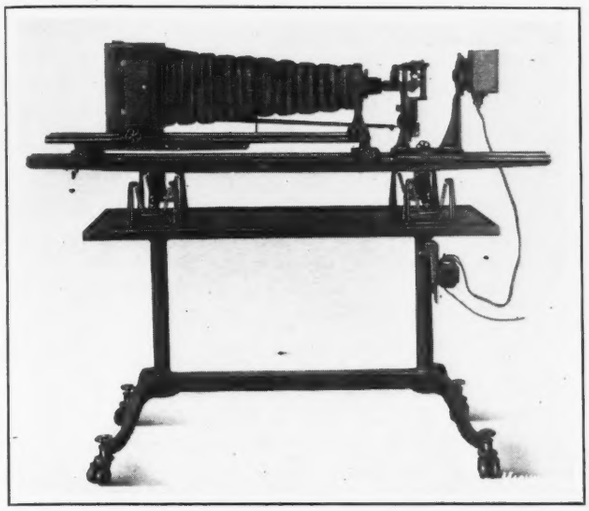


Fig. 1. Metallographic Outfit Complete with Camera, Shock Absorbers, and Supporting Stand

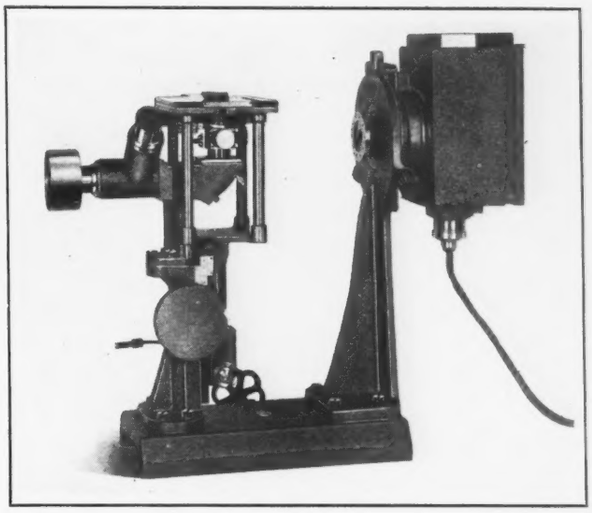


Fig. 2. Close-up View of the Metalloscope removed from the Camera Bed

used. The vertical illuminator is fitted with a sliding plate by means of which it may be removed from the microscope, although it is centered with reference to rotation about its vertical axis and locked in position. When greater illumination is desired or an oblique illumination, with a lower power, a semicircular mirror is supplied for use in place of the clear glass reflector.

AMERICAN CHIP CRUSHING MACHINE

For crushing metal borings and turnings, metal scrap balls, etc., so as to allow a much larger weight of scrap chips to be stowed away or shipped in the same space, the American Crusher & Machinery Corporation, 1 Madison Ave., New York City, is placing on the market two machines which are here illustrated. Another incidental advantage of crushing the chips is that a much larger percentage of oil can be reclaimed from them than when the chips are longer and winding. The machine shown in Fig. 1 has a capacity for crushing approximately five tons of steel chips per eight-hour day, and the machine shown in Fig. 2, about the same number of tons per hour. The smaller machine may be equipped with either a belt or motor drive, but the larger machine is always belt-driven. An idea of the principles upon which these machines operate may be obtained from Fig. 3 which presents a sectional drawing of the larger machine.

There is a hopper *A* into which the chips are shoveled and around the inside of which are arranged a number of knives as at *E*. Rotating in this hopper is a holder *B* on which are also mounted knives *I*. The hopper is secured to base *C*, at the center of which is located the vertical shaft *D* to which holder *B* is attached. As holder *B* revolves, the chips in the hopper are worked down between knives *F* and *G* and become disintegrated into the size desired. The crushed chips slide down the inclined section of the base to the floor. Holder *B* can be moved vertically about 1 3/16 inches together with the head that holds knives *G*.

It is intended that the larger machine be installed on one floor of a shop with the top of the hopper just extending through the ceiling to the floor above, or else a stage erected around the hopper. A wooden bin should be built around the hopper for the sake of safety and to permit loading the machine with a larger supply of chips at one time. The floor around the hopper on the same side as the discharge incline could be a grating with holes of sufficient size to per-

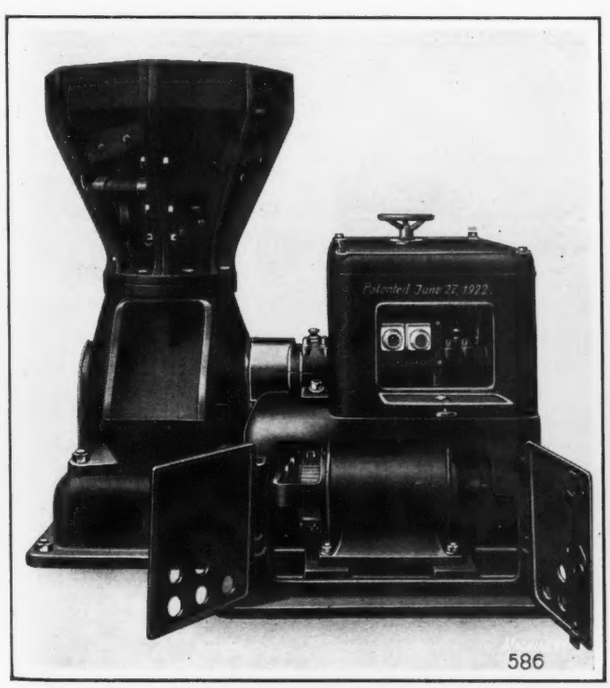


Fig. 1. Machine built by the American Crusher & Machinery Corporation for crushing Metal Chips

Fig. 2. A Larger Size Machine with a Capacity for crushing Five Tons of Turnings per Hour

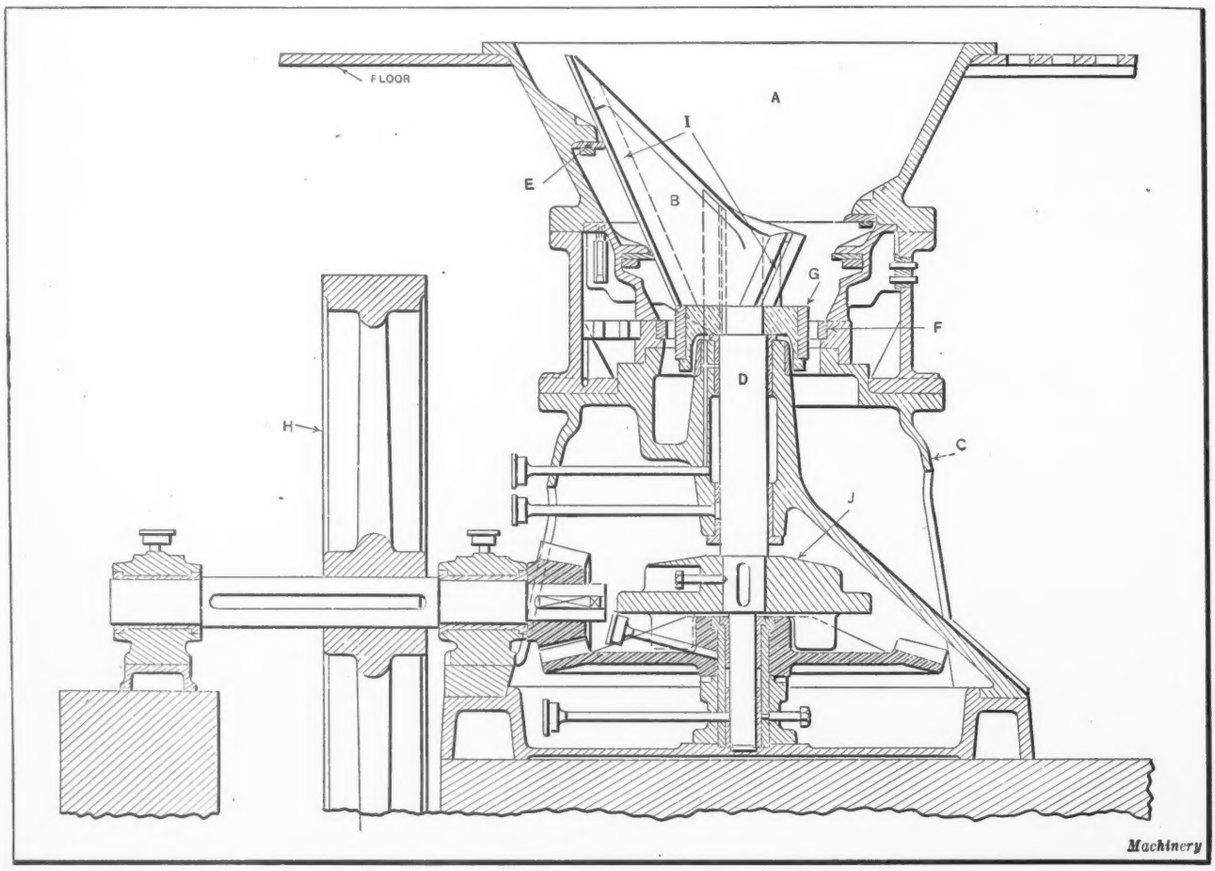


Fig. 3. Sectional View which shows the Arrangement of the Crushing Knives and also the Drive

mit the smaller chips to fall through and on the discharged heap.

The drive to the machine is through pulley *H* which also serves as a flywheel. When the smaller machine is driven by a motor gear teeth are cut directly on the periphery of this flywheel. From the pulley shaft, power is transmitted to vertical shaft *D* through the bevel gears and clutch *J*. The large bevel gear rotates idly on a sleeve surrounding shaft *D*, the drive being transmitted to this shaft when the teeth of clutch member *J* are meshed with mating clutch teeth on the large bevel gear. The drive can be arranged on either side of the discharge incline or directly on the opposite side. When on the opposite side the driving motor, gear, etc., can be completely enclosed. The smaller machine weighs about 1 ton and the larger machine, 4½ tons.

DAVIS "ROTORMATIC"

For boring and facing the sleeves of Knight automobile engines the Davis & Thompson Co., 251 Reed St., Milwaukee, Wis., has built the continuous automatic machine here illustrated. This machine is of the duplex type with a spin-

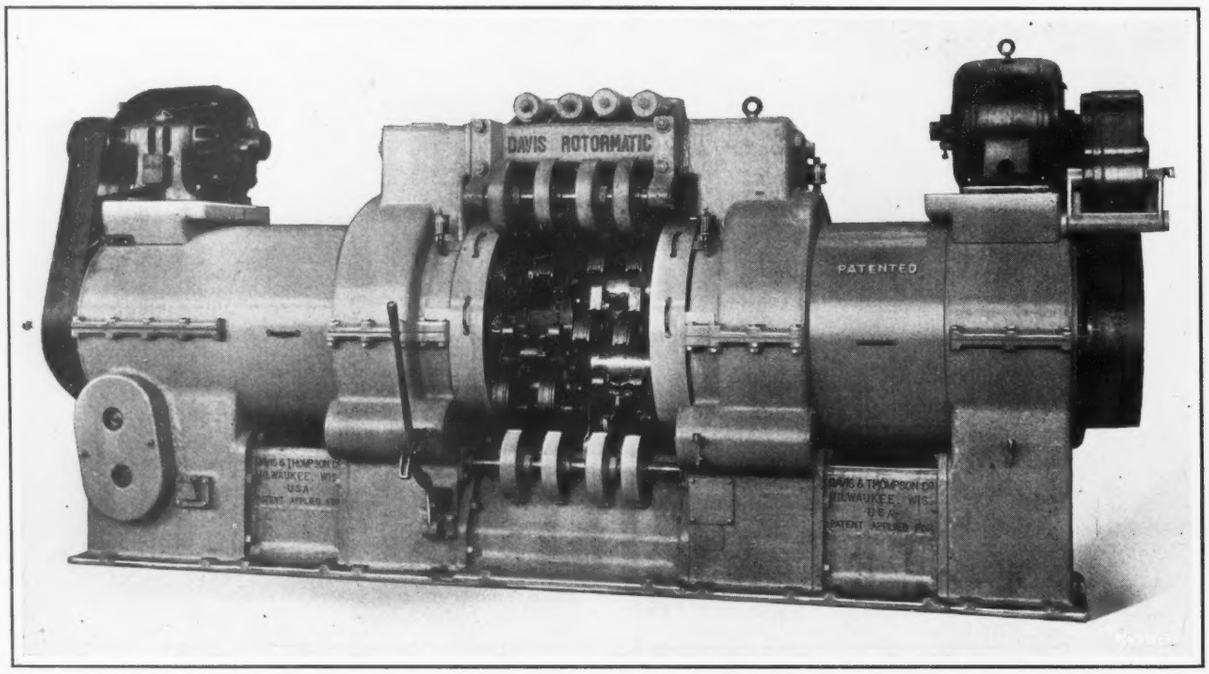


Fig. 1. Davis & Thompson Continuous Automobile-engine Sleeve Boring and Facing Machine

dle head at both ends in each of which there are six cutter-spindles. The housings in which the spindles are mounted revolve continuously with the work, the necessary longitudinal movements of the cutters being obtained through cams, one of which can be seen at the left in Fig. 3. The boring tool has a traverse of 14 inches and the facing tool of 2½ inches.

The work is carried around the machine during the operation while held properly relative to the cutter-spindles by means of the clamping levers shown raised in Fig. 2, which is a close-up view of the central portion of the front of the machine. These levers are lowered firmly on the work as they approach the top of their circle of revolution and pass down the back, by means of the chains shown in Fig. 3. In order to permit a better view of the chains and the cam previously mentioned, several guards were removed when this photograph was taken. When each clamping shoe comes into contact with the chains, a toggle pressure is exerted on the work so that it is held rigidly while being bored. As the work again reaches the front of the machine from the bottom the clamping shoes automatically raise to permit quick reloading.

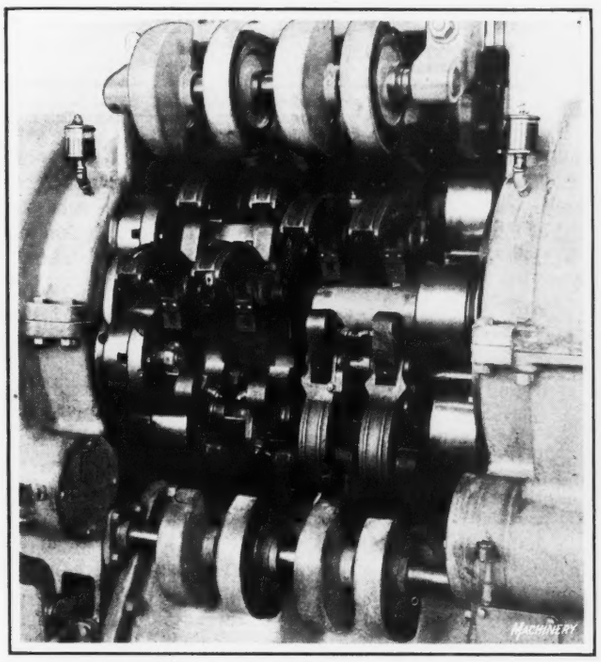


Fig. 2. Close-up View of the Work Clamping Shoes opened to permit reloading

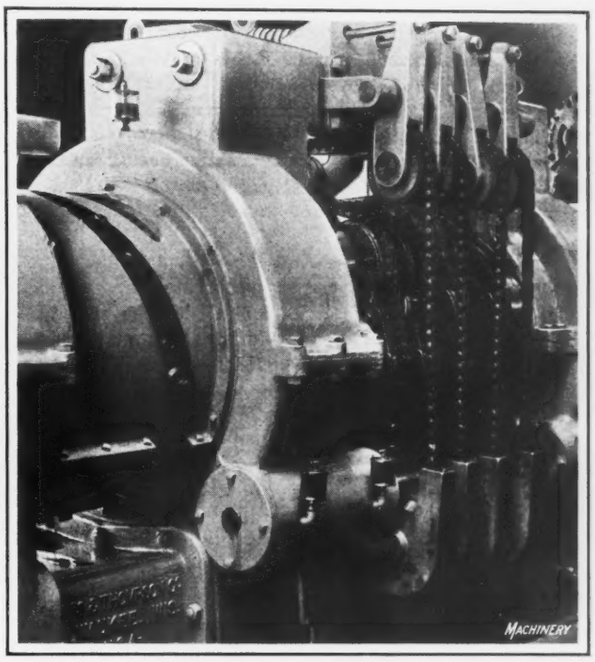


Fig. 3. Shoe Closing Chains as arranged at the Rear of the Sleeve Boring and Facing Machine

The gearing for the machine is located in the work-drums, there being two sets of change-gears which enable any desired rotary speed of the work-drum relative to the rotation of the spindles. Nearly all working members of the machine are automatically lubricated. The machine may be built with a distance between the ends of any dimension to suit different classes of work. A feature of interest in addition to those already mentioned is that the machine is adapted to threading pipe up to 4 inches in diameter. A patent for this machine was granted on May 9, 1922.

JOLITE HIGH-PRODUCTION CUTTING TOOLS

Jolite is a high-speed steel treated by a special process by which it acquires, to a greater degree than ordinary high-speed steel, the property of "red hardness." Thus a tool made from this material can be ground to a keener cutting edge than would otherwise be feasible and will still stand up for long periods between grindings. It is also claimed for this specially treated material that it holds its cold cutting edge until the necessary red hardness temperature has been reached. The Jolite Tool Co., 610 Sycamore St., Milwaukee, Wis., is the manufacturer of this product.

The process by which this material is treated makes it possible to obtain a uniform product, and as the treatment affects the steel throughout its mass any further heat-treatment is unnecessary after it has been placed in the hands of the user. The prolonged life and the added strength of the edge of the cutting tool, which are the principal claims for this process, make it possible to gain other operating advantages. The keener cutting edge reduces the power necessary for cutting, and the additional strength of the edge permits of greater feeds, which results in a reduction in power per pound of metal removed. It is also stated that the process so affects the structure of the cutting steel as to give it greater resistance to wear, which, in turn, makes it easier to hold the size of the work being cut without resetting the tool, and also eliminates frequent regrindings.

The process is used for making both ordinary lathe tool bits and formed cutters, and it has even been applied to spirally fluted hobs. One large manufacturing plant in the Milwaukee district which keeps careful records of results reports greater production between grindings, and also states that, because of the reduced wear, the life of the hob was several times greater than that of hobs made from materials formerly used by this company. A similar report has been obtained from a plant in the Detroit district, where a formed cutter used for finishing connecting-rods gave several times the production that had previously been obtained. In inserted-tooth cutters, blades made from Jolite have proved satisfactory because of the strength of the cutting edge, which enables the blades to stand up to the work on hard castings with a rake angle of from 12 to 15 degrees, thus giving the tool a keen cutting action. One of the large automobile plants is stated to have increased the production on engine blocks 25 per cent, with no breakage of the teeth and with a greatly increased life of the blades.

There are a number of directions which must be taken into account by users of Jolite tools if satisfactory results are to be obtained. Jolite tools must not scrape or drag against the metal being cut. In that case they will give no better results than any other cutting tool. The user should understand that the tool must approach the work in such a way that there is quite an acute rake angle and also sufficient clearance angle. Any attempt to re-heat-treat Jolite

tools will destroy the properties in the steel. As Jolite is a high-speed steel, the speeds used for the material to be cut are determined in the same way as for high-speed steel that has not been treated by this special process.

The cost of this material after treatment, according to the character and design of the tool, is about double to three times the cost of high-speed steel. It is stated that its cost is amply justified by the large increase in production that had been found possible by the use of this cutting metal.

CINCINNATI GEARED-HEAD LATHE

The latest addition to the line of lathes built by the Cincinnati Lathe & Tool Co., 3207-11 North St., Oakley, Cincinnati, Ohio, is the 30-inch geared-head machine here illustrated, the sizes of these lathes now ranging from 16 to 30 inches swing, inclusive. The aim of the designers in developing this machine was to produce a construction that would withstand the strains imposed in taking the heaviest cuts with the best high-speed steel tools. The interior of the headstock can be inspected through an opening in the top of the cover without removing the cover from the head. Twelve spindle speeds are obtainable in geometric progression, from 9 to 325 revolutions per minute, these speeds being secured with only thirteen gears. It is said to be possible to make the entire twelve changes in as many seconds. The low gear velocity of the head results in a quiet-running unit. The shifting levers are so located as to insure ample clearance and make it impossible to cramp or pinch the hands.

Through a splash system, oil is supplied copiously to all bearings even when the lowest speeds are being used. An indicator shows the amount of oil in the base of the head. An oil settling tank and a drain are also provided. The large bronze headstock bearings can be adjusted without removing the cover. A plunger in front of the headstock is operated to lock the face gear when a "frozen" chuck or faceplate is to be removed. When the machine is motor-driven, the motor may be mounted on the headstock or on the rear of the cabinet leg, as shown in Fig. 2. In either case the drive from the motor to the spindle is through a silent chain. The clutch pulley is supported on the driving shaft without overhang, and an oil reservoir keeps the pulley well oiled when it is running idle.

A spindle-control lever is supplied both at the right-hand end of the apron and on the headstock to start and stop the lathe, and if desired an additional lever can be supplied on top of the headstock. The patented quick-change gearing gives thirty-two changes of feeds or threads by merely shifting two levers, and the range is unlimited. Some of the principal specifications of this machine are as follows: Swing over bed, 30¼ inches; swing over bottom slide, 21 inches; maximum distance between centers on a lathe equipped with a 12-foot bed, and with the tailstock set flush, 84 inches; size of motor required, 10 horsepower; and weight of machine equipped with 12-foot bed, about 10,200 pounds. In an operation on a bar of 0.50 per cent carbon steel 6½ inches in diameter, using a high-speed steel tool, a cut ½ inch deep was taken with a ⅛-inch feed and with the work revolving at 115 revolutions per minute.

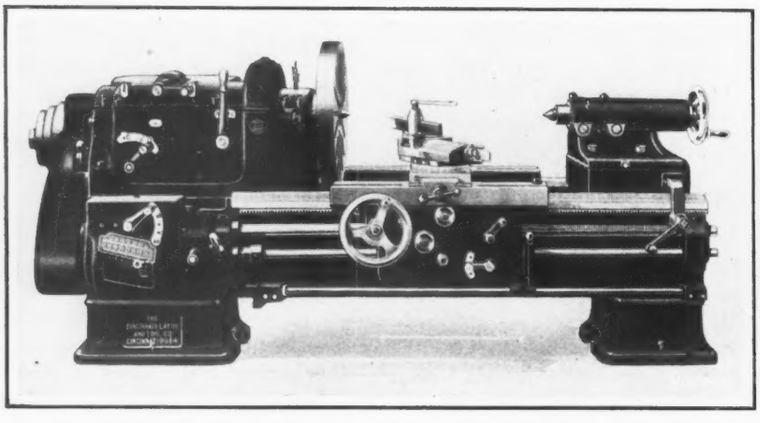


Fig. 1. Cincinnati 30-inch Geared-head Lathe with Single-pulley Belt Drive

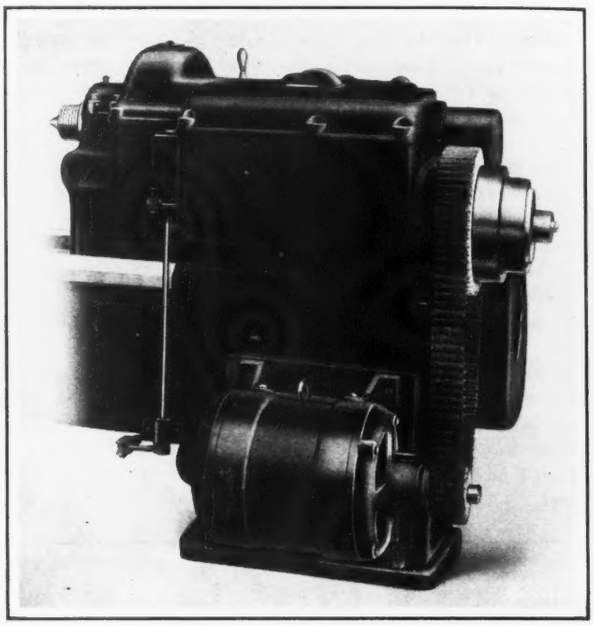


Fig. 2. Lathe equipped with One of Two Types of Motor Drive

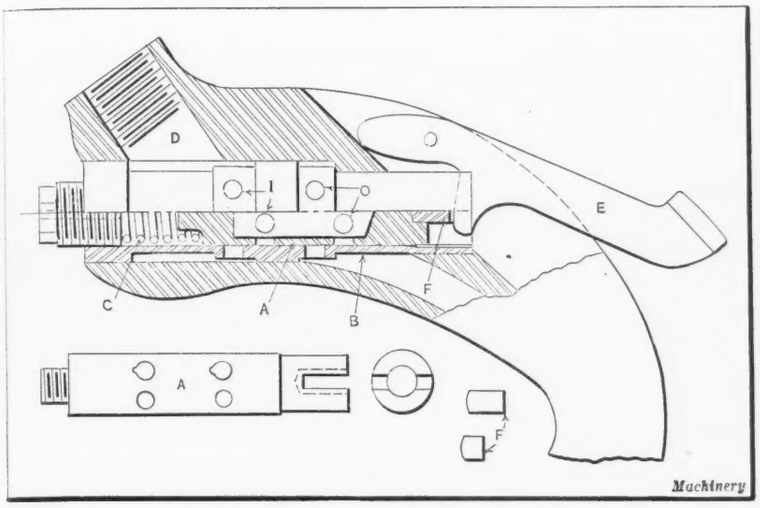
INGERSOLL-RAND AIR-MOTOR HOISTS

Five different sizes of air-motor hoists of the type illustrated and described in November, 1923, MACHINERY are now manufactured by the Ingersoll-Rand Co., 11 Broadway, New York City. The 500- and 1000-pound sizes of these hoists each weigh 150 pounds when equipped with a top hook; the 2000-pound size, 315 pounds; the 4000-pound size, 425 pounds; and the 10,000-pound size, 760 pounds. The maximum lift for all sizes is 15 feet and the rate of lift with an air pressure of 80 pounds per square inch ranges from 10 feet per minute for the largest size to 50 feet per minute for the smallest. The hoists operate on air pressures of from 60 to 100 pounds per square inch.

The features claimed for these hoists are: Compactness of design, requiring but a low head-room; relatively light weight; automatic brake which holds the load under all circumstances, even if the air supply should be disconnected or fail; and a graduated throttle which permits a close regulation of the lifting and lowering speeds. The air cylinder is of a balanced three cylinder type which operates in either direction and without vibration at any speed or load within the capacity of the hoist. Either a roller-bearing monorail trolley or a top-hook mounting can be provided. The trolley mounting reduces considerably the head-room necessary for installing. Furthermore, because of its rigidity, which enables an operator to easily start a loaded hoist along a runway, it proves more satisfactory than hooking the hoist on a separate trolley unit.

BAILIE PNEUMATIC THROTTLE VALVE

A patented throttle valve designed for use in portable pneumatic riveting hammers and similar tools is manufactured by Samuel Bailie, 311 Cooper St., Camden, N. J. The device consists essentially of a



Bailie Throttle Valve for Portable Pneumatic Tools

sliding valve *A* and valve tube *B;* the illustration shows the valve in the closed position, in which it is held by means of spring *C*. The latter is compressed between the valve and a plug screwed into the outer end of the tube. Spaced equidistantly around both the valve and tube are a series of six inlet port holes *I*, and a similar series of outlet port holes *O*. When both series of the valve and tube port holes are located, as shown, relative to each other, no air can enter the handle from inlet *D*, but when valve *A* is moved horizontally so as to register the different holes of the valve and tube with each other air is admitted through holes *I* into the hollow portion of the valve and then through holes *O* into the handle for operating the tool.

This horizontal movement required to open the valve is accomplished by depressing the thumb end of lever *E*. This lever has a lug that seats in a slot in the inner end of the valve and in pin *F*. The pin provides a means of adjusting the length of the valve, a shorter one being required for a closed handle than for an open handle. With this exception, the device is interchangeable for open and closed handles.

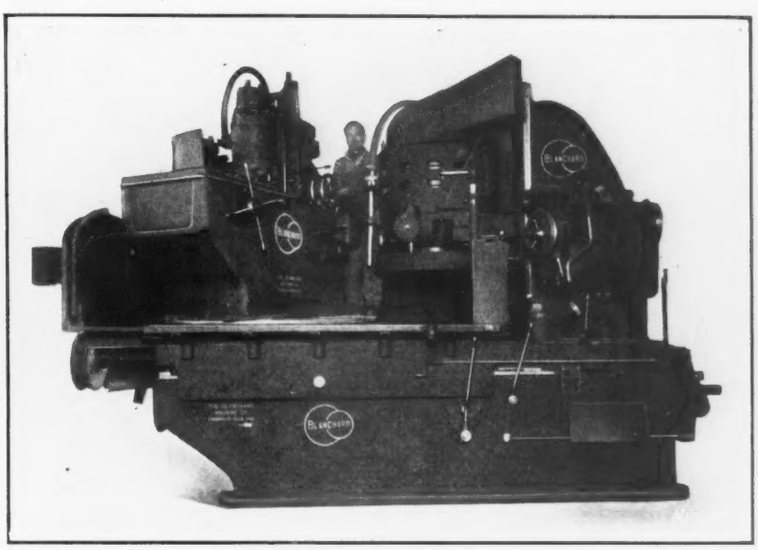
The principal claim made for the valve is that it is leakproof, and rust or other foreign matter cannot lodge between the sealing surfaces of the valve and tube. In fitting this valve to a handle, the original tube can be reamed out to suit the valve. A small advance opening provided in two of the valve port holes provides a sensitive control of the tool.

BLANCHARD GRINDING MACHINE

What is believed by the builder to be the heaviest and most powerful surface grinding machine in existence was recently built by the Blanchard Machine Co., 64 State St., Cambridge, Mass. This machine is known as the "Special No. 27-R" and is here illustrated with a No. 10 Blanchard grinding machine and a man standing on the rotary chuck to give an idea as to its size. The regular No. 27-R machine was described in MACHINERY for May 1922. It takes a 27-inch grinding wheel and either a 48- or 60-inch magnetic chuck. The special machine, however, is equipped with a 36-inch grinding wheel and a 60-inch magnetic chuck with an extension ring 76 inches in diameter added to it.

In addition to the changes mentioned the water guards have been widened and the base of the machine lengthened and there have been other minor changes which permit of swinging work up to 84 inches in diameter. The wheel-head contains a 60-horsepower alternating-current motor and, complete with the grinding wheel, weighs 7000 pounds. This is considerably more than the entire weight of the No. 10 grinder on the chuck. In spite of the weight the head is accurately controlled through feed gearing so that work can be ground to size within plus or minus 0.001 inch.

Four speeds are provided for the rotation of the chuck, these being obtained through a sliding-gear speed box. The gears are made of alloy steel and heat-treated, while forced or bath lubrication is supplied to all bearings. The base is cast in one piece weighing 11,800 pounds and forms a tank for 500 gallons of coolant. The coolant is pumped to the inside of the wheel and to the outside nozzle by a centrifugal pump equipped with a 2½-inch discharge pipe. The chuck is traversed by power from the loading to the grinding position. Part of the water guards move with the chuck and table so that as the chuck moves out after grinding work, this outward movement of the table provides part of the opening necessary for removing the work. The full width or opening of the guards is obtained by swinging one section around the corner on suitable tracks. The total weight of the machine is about 43,000 pounds and the floor space occupied, 15 feet 9 inches by 8 feet.



Blanchard Surface Grinding Machine of Unusual Size

STOCKBRIDGE METAL-CUTTING BAND SAW

A high-speed band saw designed to cut all kinds of metal and to operate successfully under varying conditions has been placed on the market by the Stockbridge Machine Co., Worcester, Mass. In this saw there is a fine adjustment for the pressure of the teeth of the band against the work, and when set, the pressure is automatic in operation. This machine is built according to the standards of machine tool construction. It will be seen from Fig. 2 that there is a carriage or ram which slides on scraped ways on the side of the column. Both disk wheels for the band saw are carried on the carriage and thus move with it. The band saw runs between two sets of guide rolls directly above and below the work, the top rolls being adjustable up and down to suit different sizes of stock.

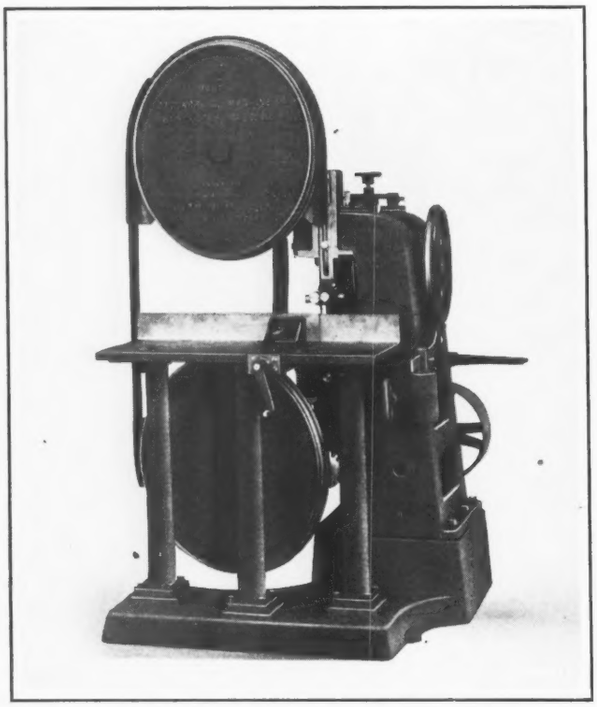


Fig. 1. Stockbridge High-speed Metal-cutting Band Saw

Attached to the ram are gravity weights which move the ram forward and keep the band against the work at a constant pressure. In addition to this, there is another provision for maintaining a constant pressure. The wheel seen in Fig. 1 on the side of the column is moved with the ram through a gear and rack mechanism. A friction pad applied against the surface of this wheel controls, by means of a balancing weight, the feed of the ram forward and the pressure of the band against the work. The position of the weight determines the amount of feed given to the ram or the speed at which it is moved forward. The combination of the gravity weight pull on the ram and the friction gives a balanced pressure control of the band, no matter what material or area is being sawed. An automatic stop can be set to disengage the feed at any point of the stroke.

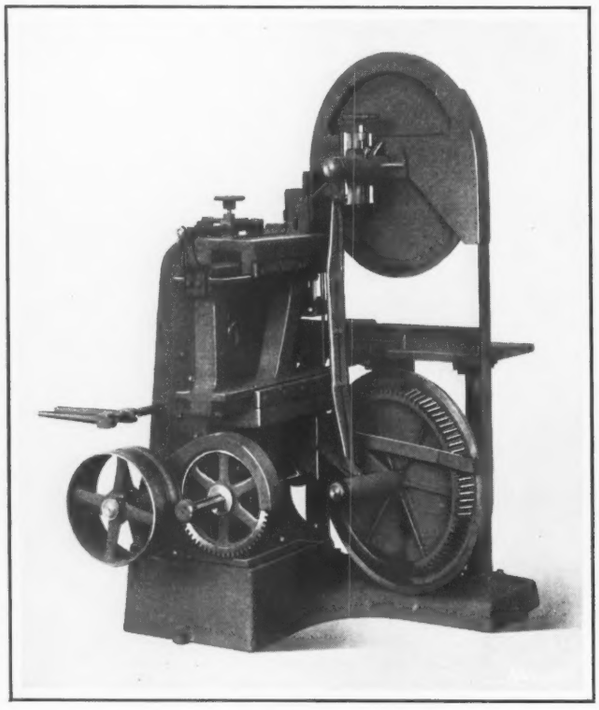
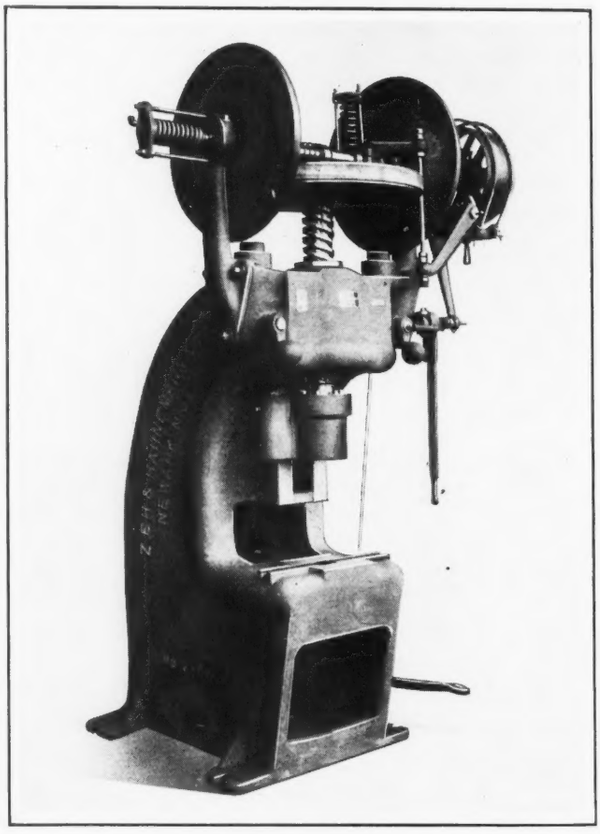


Fig. 2. Driving Mechanism, Construction of Ram, etc.

The fixed guide rolls are carried on Hyatt roller bearings, and the tension guide rolls are supplied with ball bearings. There are special self-oiling bearings for the band wheels. A pivoted tension screw is provided in a slide to keep the band taut and in alignment when in use. Either a belt drive direct from a lineshaft to the tight and loose pulleys on the driving shaft of the machine or a direct-connected motor drive can be furnished. It is mentioned that this machine has been used for cutting off disks that had to be true and square within 0.005 inch. Though primarily designed for cutting stock from the bar, such work as shells, pipe, I-beams and angle-irons can also be handled. The blades used are 1/32 inch thick. This band saw is built in three sizes, one of which handles round or square stock up to 6 inches, the second up to 9 inches, and the third up to 12 inches. The machine is built under the Houghton & Richards patents.

ZEH & HAHNEMANN PERCUSSION PRESS

Another type of press known as the No. 2–8½ has been added to the line of patented percussion power presses built by the Zeh & Hahnemann Co., 182-200 Vanderpool St., Newark, N. J. The normal pressure rating for this machine is



Zeh & Hahnemann Patented Percussion Press

75 tons, but a pressure of 115 tons was developed in a test. The frame is a steel casting, constructed with an open cap or throat to permit long work to be handled sidewise, as well as from front to back. The machine was primarily designed for use in cold-riveting rails and ties for industrial railways and for forming operations. The main feature claimed for this class of presses is the cumulative blow delivered, all the energy of the flywheel being utilized as it comes to a dead stop.

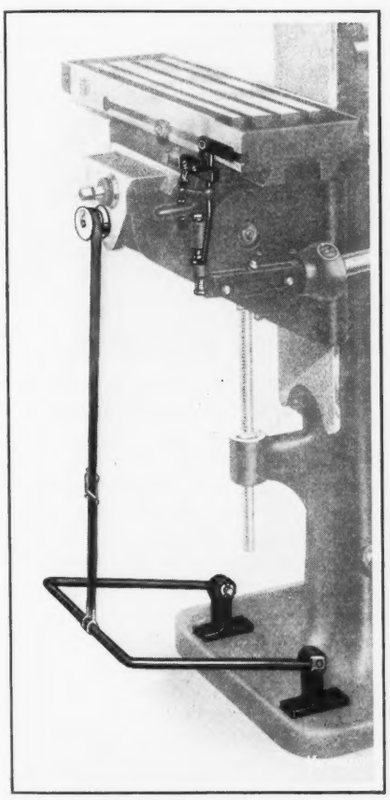
The main screw is made of a special steel, heat-treated, and runs in a bronze nut of considerable length. A high mechanical efficiency is claimed for the machine, the only frictional losses being those of the screw, and as the screw has a coarse pitch, these losses are relatively small. All

bearings are equipped with ball races. A brake at the top of the flywheel promptly stops the moving parts at the end of the upward stroke and then holds the brake in a neutral position. There is also an emergency stop beneath the flywheel which prevents damage in case the press is tripped while empty. If this provision were not made, the flywheel would strike the top of the frame and injure the screw. It will be evident that the friction drive accelerates the flywheel gradually. A tightening device is provided for the friction band of the flywheel to permit taking up slack at any time.

A few of the important specifications of this machine are as follows: Diameter of screw, 4¾ inches; depth of throat, 12 inches; stroke of slide, 8½ inches; distance from bed to slide when the latter is down, 7 inches; opening between housings, 15 inches; number of strokes per minute, 20; horsepower required, 3½; and weight, about 8500 pounds.

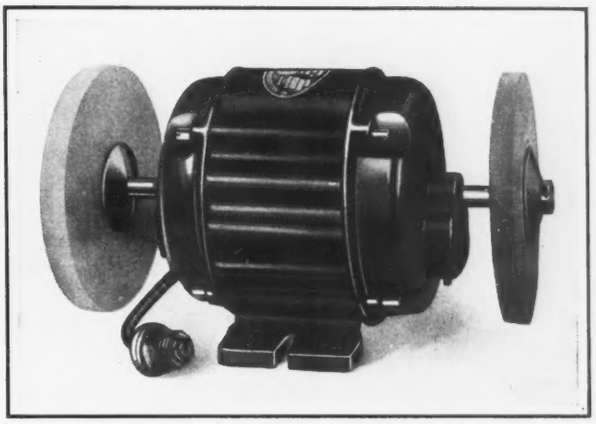
ATTACHMENT FOR B & S MILLING MACHINE

An attachment has been brought out by the Brown & Sharpe Mfg. Co., Providence, R. I., for converting the No. OY plain milling machine from a hand-operated into a semi-automatic machine, thus adapting it for rapid-production work. The attachment consists of a few simple parts which can be readily applied to the machine. The table-feed hand-crank is replaced by a pulley about which is wrapped a web belt extending down to a foot-treadle. By depressing the treadle, the pulley is made to rotate and move the table to the cutting position, at which point the feed is engaged. At the same time a heavy spring is compressed. Upon the completion of the cut a trip-dog disengages the cutting feed, and the spring automatically returns the table to the loading position.



Attachment for B&S Plain Milling Machine

The attachment reduces the required hand movements from five to two, and the non-cutting time 50 per cent. Besides these advantages, the work is carried rapidly to the cutting position with little effort on the part of the operator, and both of his hands are free to adjust the work. An additional important feature is the fact that the attachment makes it impossible to "jam" work into the cutter. Production is materially increased if the cutting and loading times are short, and if the loading time is shorter than the cutting time, two machines can be run by one operator, as the table return is automatic. On sixteen jobs taken at random from operations adapted to the machine an increase in production of over 20 per cent was obtained when the machine was equipped with this attachment, using the same feeds and speeds as when the operations were performed on the machine not provided with the attachment.



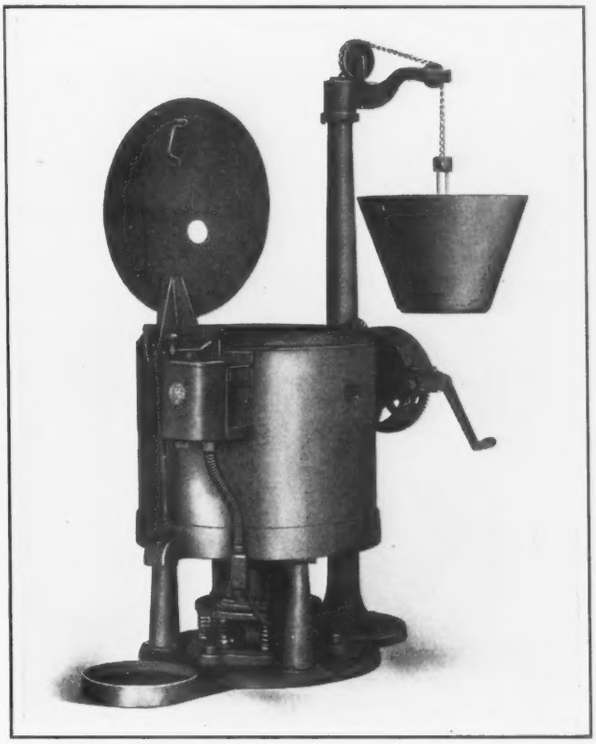
Marathon Grinder and Buffer

MARATHON GRINDER AND BUFFER

A model No. 11 grinder and buffer has just been placed on the market by the Marathon Electric Mfg. Co., 34 Island Ave., Wausau, Wis. This equipment is intended for general use in machine or repair shops and garages. It is driven direct by a Marathon O. K. motor of ¼ horsepower capacity, running at 1740 revolutions per minute. The motor is totally enclosed and dustproof, and may be supplied for either alternating or direct current. The grinding wheel is 6 inches in diameter by ½ inch thick, while the unsewed cotton buffing wheel is 7 inches in diameter by ⅜ inch thick. A pedestal base, with on and off switch, wire wheel, and other accessories may also be furnished.

CURTIS OIL EXTRACTOR

A direct motor-driven oil extractor for which smoothness of operation is assured through a compensating arrangement that transmits all vibration to the base of the machine, is being placed on the market by the Curtis Machine Co., Worcester, Mass. The motor is mounted directly on the spindle of the machine so as to eliminate all intermediate driving parts, and is operated through a drum-type



Curtis Direct Motor-driven Oil Extractor

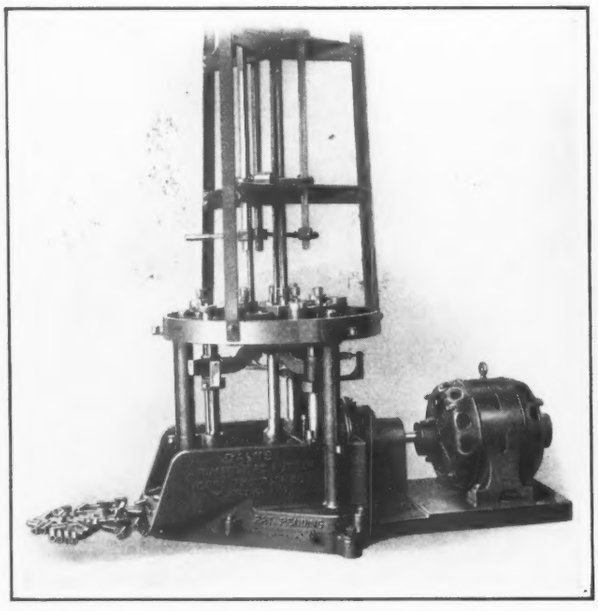


Fig. 1. Davis Automatic Pipe Cutting Machine

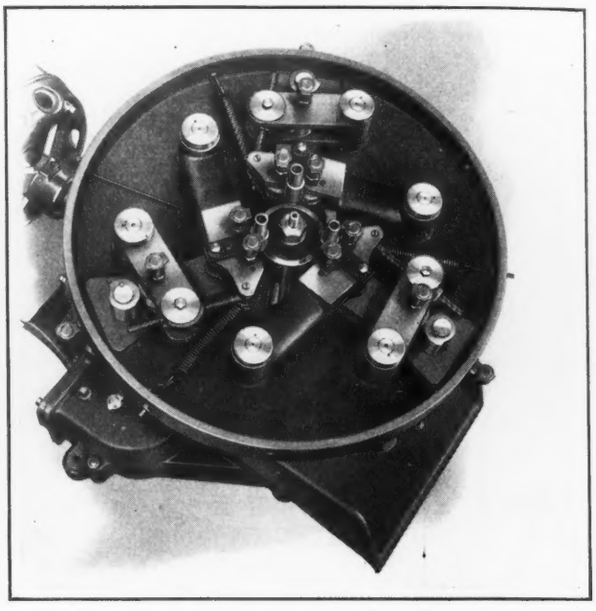


Fig. 2. The Roller Cutter and Work-holding Mechanism

controller conveniently located as shown. A three-horsepower squirrel-cage motor running at 1200 revolutions per minute, and operating on either 220-, 440-, or 550-volt, 60-cycle, three-phase, alternating current, is provided. The machine may be accelerated under full load in ten seconds and stopped in twelve seconds.

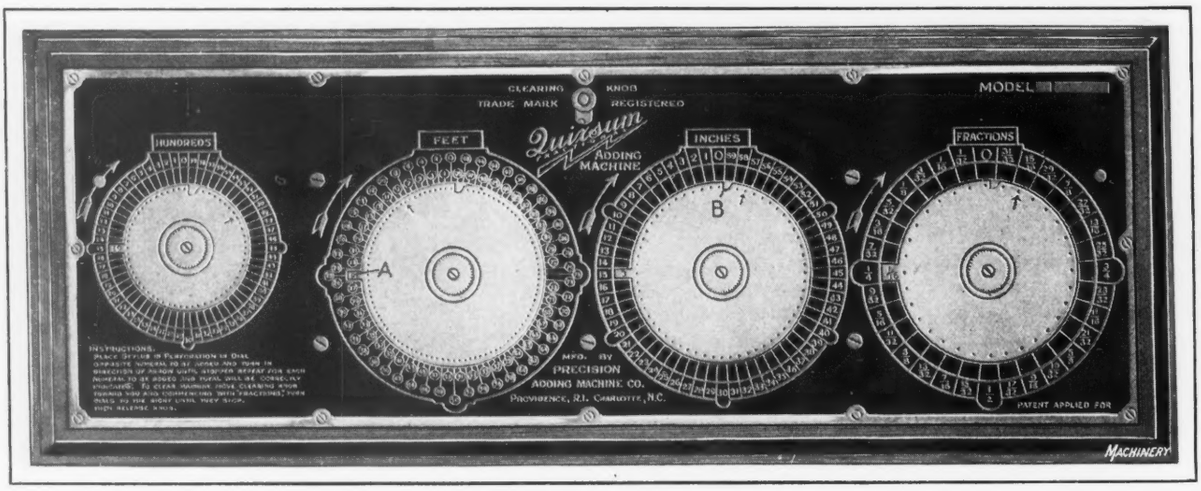
The details of bearings and lubrication have been so worked out as to prevent either lubrication or foreign matter from getting into the motor parts. The motor is equipped with Timken bearings, the lower bearing carrying radial loads only, and the upper bearing both radial loads and the thrust load of the pan assembly, chips, and spindle. The weight of the entire assembly, comprising the motor and pan, is carried by a pivot bearing in the base. A safety cover automatically locks the drum control when raised, and thus operation of the machine is only possible when the cover is closed. The chip pan has a capacity of two bushels.

DAVIS AUTOMATIC PIPE CUTTER

A machine for automatically cutting off ¼- to 2-inch pipe in lengths of from 1 to 8 inches has recently been developed by the Davis & Thompson Co., 251 Reed St., Milwaukee, Wis. Lengths of pipe up to 6 feet can be handled. Three pipes are cut at one time while held vertically by the guide shown in Fig. 1 attached to the top of the machine. The cutting is accomplished by means of a cutter of the standard roller design. Each of the three pipe lengths falls down on a cam-operated lever, where it is held in position until the cam on top of the machine forces the pipe against the cutter. When the cutter has been fed well through the pipe, the cam moves the lever away until the cut-off piece drops from the stock, at which time the lever returns into position for stopping the falling stock. A good view of this mechanism is illustrated in Fig. 2. In cutting off ¾-inch pipe nipples, the production per hour is 4000 pieces.

"QUIXSUM" ADDING MACHINE

A laborious job often met with in the drafting-room and other engineering departments is to add up dimensions given in feet, inches, and fractions of an inch. To facilitate such calculations, the Precision Adding Machine Co., Gotham Bank Bldg., New York City, has placed on the market the "Quixsum" fractional adding machine shown in the accompanying illustration. On this device there are four dials, one for fractions of an inch, one for inches, one for feet, and one for hundreds of feet. There is a series of holes around each dial to receive the point of a stylus, and beside each hole there is a number, such as ⅛ on the fractional dial, or 42 on the inch, feet, or hundred-feet dials. These

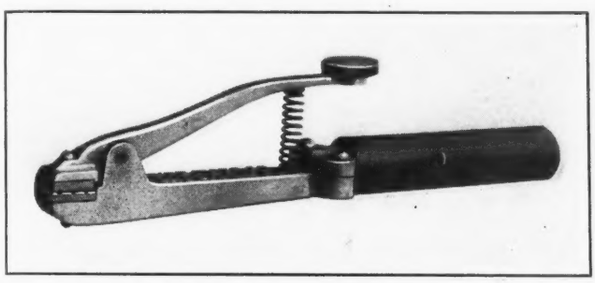


Quickly Operated Device for adding Lengths of Feet, Inches, and Fractions of an Inch

numbers are hidden by the cover of the device, except at slot *A*. On the portion of the cover immediately surrounding each dial, there is also a number for each hole on the dials.

When the machine is set for commencing a calculation, a 0 appears at each slot *A*. The stylus point is placed successively in the hole on the different dials opposite the numbers on the covers that are to be added, and the dials are turned clockwise until the stylus strikes stop *B*. If such a number as 2 feet 3¼ inches is to be added to another number, the stylus is first inserted in the hole opposite 2 on the foot dial, and this dial turned as described, after which the stylus is inserted in the hole opposite 3 on the inch dial, and this dial turned, and finally the stylus is placed in the hole opposite ¼ on the fractional dial, and this dial revolved. After one value has been recorded, others are recorded in the same manner without paying any attention to the numbers appearing in slots *A* until the calculation is completed, when the result is read from these slots.

Before proceeding with a second addition, all dials must be returned to 0, and this is quickly done by pulling down the clearance knob near the top of the device at the middle, and then turning the knob at the center of each dial. In each case when 0 is registered, a locking action prevents further turning of the dial until the clearance knob is pushed back. The dimensions of this adding machine are 15 by 5¾ by 1¼ inches, and the weight about 3 pounds.



Gibb Electrode-holder for Use in Arc Welding

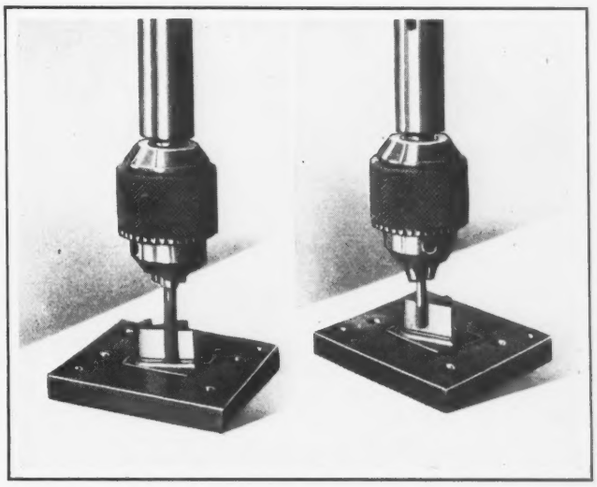
GIBB WELDING ELECTRODE-HOLDER

The principal claim advanced for an electrode-holder placed on the market by the Gibb Instrument Co., Bay City, Mich., for use in arc welding, is that it will not heat up in welding operations. This feature is said to have been obtained by providing an air-cooled fiber handle and locating the cable connection in front of the handle. The main castings are made of aluminum, and as a consequence the weight of the holder is only about 15 ounces. The thumb piece is also made of fiber.

In welding operations, the wire electrode is frequently used to the last fraction of an inch, in which case an arc is likely to be drawn on the holder, and an arc may also be occasioned by the wire sliding in the holder. The jaws of a holder are ruined when arcs have occurred only a few times, and for this reason the copper jaws of this holder are made renewable. The spring between the jaw lever and the main handle is exposed, so that it will not become overheated, and this part also may be readily replaced.

ROTARY DIE-MAKING FILES

Filing punches and dies by hand is a tedious operation because small files and a short stroke are usually necessary, and it is also a costly method, because a skilled diemaker is required for the work, and it takes a considerable amount of time. To eliminate hand-filing and thus reduce the cost of punches and dies, the Rotary File Co., 1570 Richton Ave., Detroit, Mich., has placed on the market a line of rotary files which somewhat resemble end-mills but are provided



Straight and "Break Clearance" Rotary Files

with finer teeth on the cylindrical surface. These files are used by holding them in the chuck of a drilling machine and gently pressing the surfaces to be filed against the revolving tool.

At the left in the illustration is shown a straight rotary file intended for the general filing of punches and dies, while a "break clearance" rotary file is shown at the right. The latter is intended for use in filing the "break" clearance on punches—that is, the clearance between the punch and die. This is done after the punch has been sheared a distance of about ⅛ inch in the die. The diameter of the file shank is smaller than the diameter of the cutting edges an amount equal to the clearance desired. Thus in cutting the clearance on a punch, the file is lowered until the upper end of the filing teeth is located, relative to the sheared portion of the punch about as shown in the illustration. Then as the work is pushed against the file, the stock is cut away until the shank touches the sheared portion, at which time the desired clearance has been obtained, the shank acting as a guide and stop.

At the end of this operation, there is a shoulder left at the sheared portion of the punch due to the reduced diameter of the file shank, but this may be quickly removed with a straight rotary file. In hand-filing operations of this kind, the depth of clearance must often be guessed at because of the impossibility of employing measuring instruments, but with this file, measurements of that kind are unnecessary. Another advantage is that the outline of the punch or die is always within plain view during an operation.

GAIRING CUTTERS AND HOLDERS

A line of type A counterbores, countersinks, and spotfacers, as well as holders for these tools, is now manufactured by the Gairing Tool Co., Inc., Detroit, Mich. Fig. 2 shows a phantom view of a plain holder with a countersink and pilot assembled, while Fig. 1 shows three styles of cutters. Each cutter has a hexagonal shank which fits a cor-

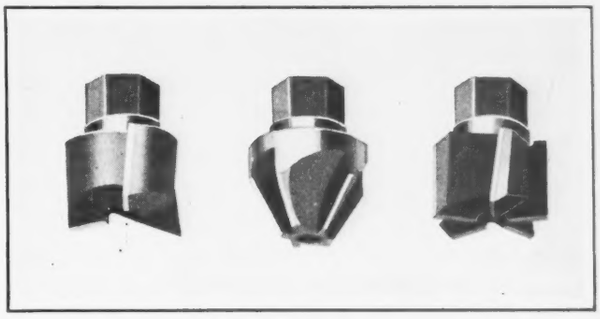


Fig. 1. Standard Type A Three- and Five-flute Cutters

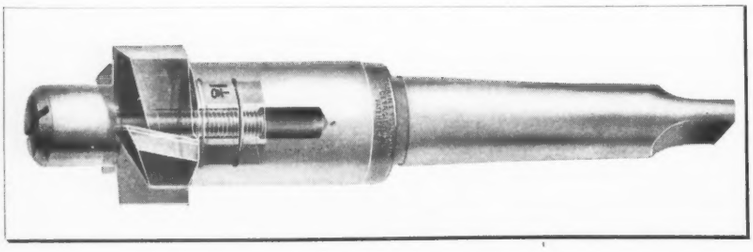


Fig. 2. Gairing Countersink and Plain Holder; the Phantom View clearly shows the Method of Assembly

responding recess in the holder. Also inserted in the hexagonal recess of the holder is a nut which is held in place by a one-coil spring seating in a groove in the holder. The pilot of the cutter has a long threaded shank which is inserted through the central hole in the cutter and screwed into the tapped hole in the nut to hold the unit together. When the requirements are such as to demand a special thread in the pilot nut, this part can be furnished tapped to suit.

The cutters are made with either three or five flutes, and are so designed as to provide ample chip clearance and to give a long life to the cutting edges. The five-flute cutters are recommended for use when the diameter of a hole is to be held accurate or a fillet is to be removed simultaneously with a spot-facing step. The three-flute cutters give the best results in cutting into flat surfaces, as they break

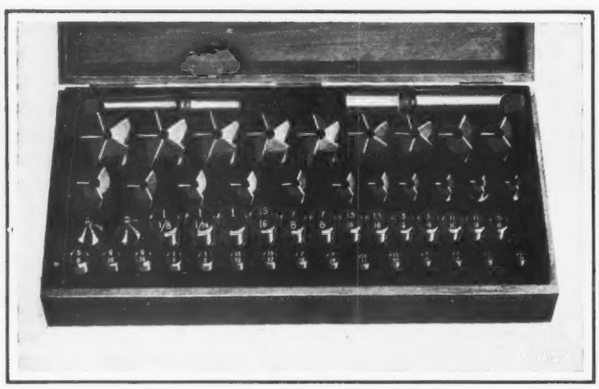


Fig. 3. Set of Cutters, Holders, and Pilots

through the scale more quickly. The cylindrical part of the shank and the shoulder of the cutting section are ground while the cutter is mounted on an arbor inserted through the pilot hole and into the ground hole in the holder, thus insuring a centralized cutter. Cutters are made from ¼ to 5 inches in diameter.

Fig. 5 shows a type A threaded holder provided with short adjusting nuts and a lock-washer which may be so set that an operation can be ended at a predetermined depth. Special longer nuts can also be provided for this holder. Both the plain holder and this type are regularly made with Morse taper shanks, but they may also be supplied with special shanks. The holders are made from nickel steel, heat-treated and ground. Gairing cutters with plain holders and pilots are regularly furnished in three sets, one of which is illustrated in Fig. 3, the cutters in this particular set ranging from 9/16 inch to 1 3/4 inches in diameter. In the other sets the cutters range from 1/4 to 1/2 inch, and from 9/16 to 1 1/8 inches, respectively. One holder is furnished with each of these sets. The fixture illustrated in Fig. 4 is built by the same company for facilitating regrinding of these cutters.

LEBLOND PORTABLE HEAVY-DUTY LATHES

Self-contained heavy-duty lathes of 11-, 15-, and 17-inch swing, are now being introduced to the trade by the R. K. LeBlond Machine Tool Co., Cincinnati, Ohio. These machines are mounted on three substantial wheels, so that they can be conveniently taken to the work, and they may receive current from any power circuit. The controlling apparatus is an integral part of the machine, and so it is only necessary to deliver the current to the switch. These machines are particularly adapted to the various classes of work met with in railway shops, arsenals, and printing plants, and on battleships. The handle provided for pulling the machine from place to place is counterweighted in such a manner that when released it secures the machine firmly to the floor, and, including the handle, the lathe occupies no more space than the regular machine of the same size. With the exception of the portable and driving features, these machines are similar in design to the heavy-duty line which was described in April, 1923, MACHINERY.

Either a geared or belted constant-speed motor drive for alternating or direct current is regularly furnished, although an adjustable-speed direct-current motor with a geared drive can also be supplied. In the geared-drive construction, which is illustrated in Fig. 1, the motor is

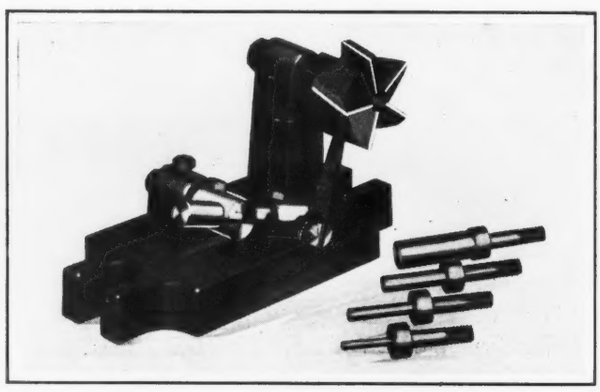


Fig. 4. Grinding Fixture for Type A Cutters

mounted on top of the headstock, and the drive is through a motor pinion and intermediate bakelite gear to a broad-faced gear that replaces the driving pulley. In all cases the full number of mechanical speed changes are retained in the headstock, there being six spindle speeds on the 11-inch lathe, nine on the 15-inch size, and twelve on the 17-inch machine.

The constant-speed belted motor driving arrangement, which is illustrated in Fig. 2, is identical with that furnished on the regular heavy-duty lathes, the motor being mounted in the front leg and the drive transmitted through

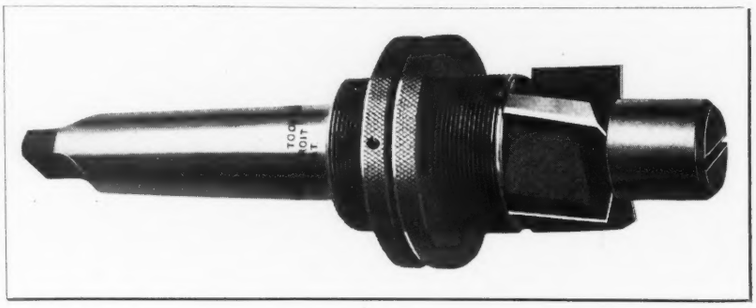


Fig. 5. Threaded Holder with Adjustable Nuts and Lock-washer for governing the Depth of Cuts

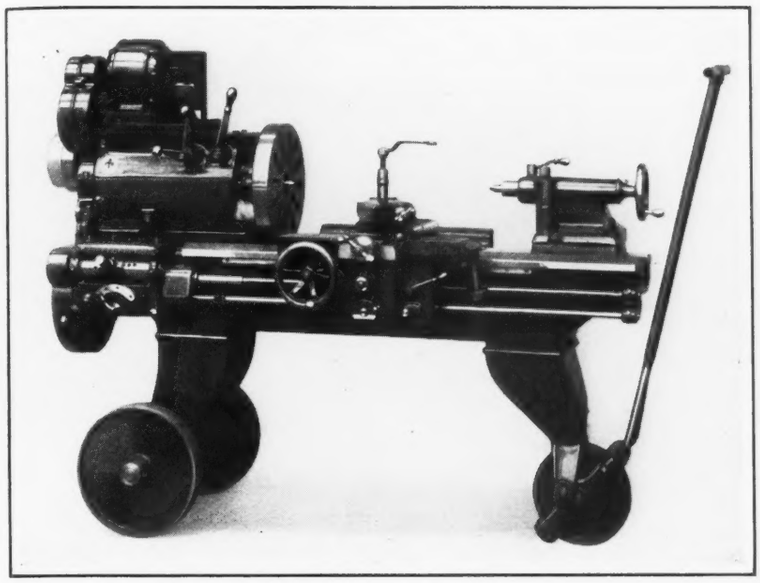


Fig. 1. LeBlond Portable Heavy-duty Lathe equipped with Constant-speed Motor Drive

a high-speed endless double leather belt to the driving pulley. A tightening pulley provides for increasing the contact area of the belt on the pulleys and for adjusting the belt tension.

These portable lathes have mechanical starting, stopping and brake mechanisms, which are operated from the front of the head-stock by plain starters or controllers. When a reverse mechanism is desired, automatic reversing controllers with a dynamic brake are required for direct-current motors, while alternating-current motors require special machine tool type reversing controllers, the point of reverse being used as a brake. The 15- and 17-inch lathes can be furnished with a simplified automobile feed instead of the regular quick-change mechanism. The automobile feed provides nine feeds which cover all requirements for plain turning and facing. The 11-inch lathe is particularly adapted for machining small pins, studs, and bolts, and for handling other general repair shop work.

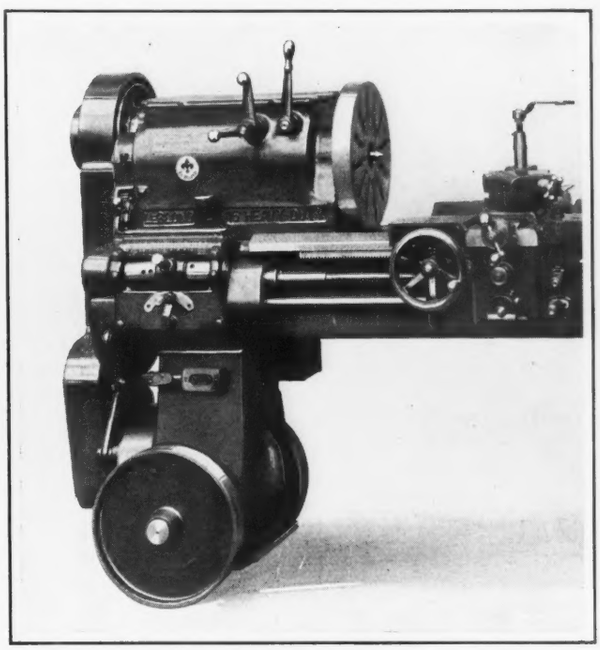


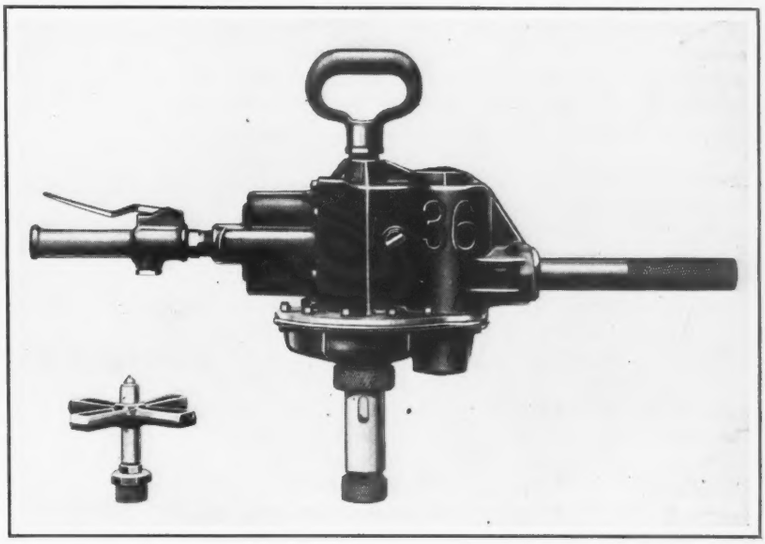
Fig. 2. Arrangement of the Headstock End with Belted Motor Drive

CHICAGO PNEUMATIC "RED GIANT" DRILL

For drilling, reaming and tapping service, the Chicago Pneumatic Tool Co., 6 E. 44th St., New York City, has recently placed on the market the No. 36 "Red Giant" portable air drill shown in the accompanying illustration. This drill has been designed to operate efficiently under a constantly fluctuating load, as the work ordinarily handled with this type of tool varies from single plates to a multiplicity of plates and gussets, with forgings or iron or steel castings interspersed. The quantity of metal removed also produces a constantly changing factor. The machine weighs about 35 pounds, so that it is light enough to be classed as a one-man machine for reaming operations.

The spindle is of the extension type, with a tang slot to facilitate the ejection of a reamer or drill. The connecting-rods are attached to the cross-head by means of a standard wrist-pin, as in steam engine practice, without the use of a connecting-rod toggle. The cylinders are of the double-acting type, and are provided with a packing gland or stuffing-box which prevents the leakage of air into the crank-case. The pistons are also of the double-acting type, and are each provided with two packing rings. The design of the cross-head and guide is such that side thrust against the pistons is obviated and cylinder wear reduced to a minimum. The eccentrics are forged integral with the crankshaft.

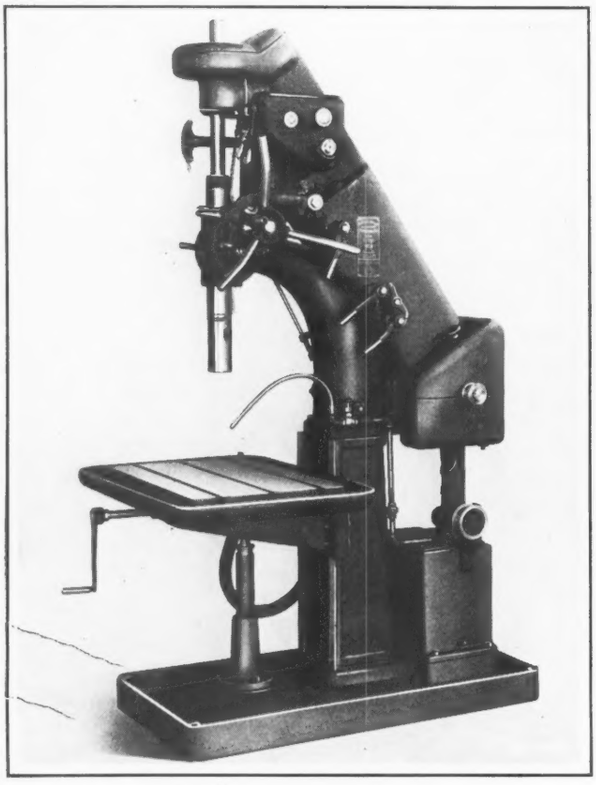
Long-wearing and leak-proof valves of the balanced piston type are furnished. They are so balanced in all directions that pressure is not required to hold them to their seats. The valves are located between the cylinders, and short ports provide an air control as close to the cylinders as possible, thus effecting an economy in the use of air. The crankshaft is forged from high-grade nickel steel, and heat-treated to obtain a high tensile strength in the throws and hardness at the wearing points. It differs slightly from the standard "Red Giant" design in that the eccentrics are located between the throws and are integral with the forging. The crankshaft is mounted in three ball bearings. The crank pinion and bull gear are of the stub tooth type. Effective lubrication is provided.



"Red Giant" Portable Air Drill designed for Drilling, Reaming, and Tapping Service

SELF-OILING ALL-GEARED DRILLING MACHINE

All sizes of the all-geared drilling machines built by the Barnes Drill Co., 814 Chestnut St., Rockford, Ill., may now be equipped with a square column and rectangular table similar to the No. 246 "Self-oiler" here illustrated. It will be seen that the table is supported underneath by the raising screw, and at the rear by a saddle gibbed to ways on the column. This construction provides greater strength and rigidity than when the machine is equipped with the regular round column and circular table, and particularly adapts the machine to production and jig work or tool-room use. It will be remembered from previous descriptions of this self-oiling machine that all gears and bearings are enclosed and constantly oiled automatically by means of a self-contained geared pump.

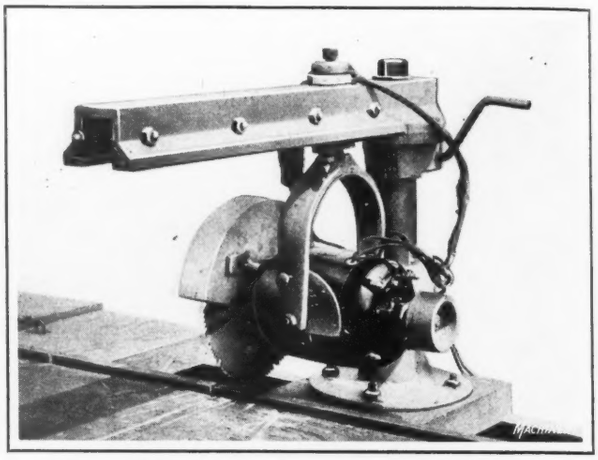


Self-oiling Drilling Machine equipped with Square Column and Rectangular Table

"DEW-ALL" WOODWORKING MACHINE

A small motor-driven woodworking machine intended to facilitate an almost endless variety of operations, such as cross-cutting, ripping, mitering, beveling, dadoing, routing, tenoning, and boring is manufactured by the De Walt Mfg. Co., Leola, Lancaster, Pa., under the trade name of "Dew-All." This machine consists of a base casting to which is attached a vertical column that is elevated and lowered by a screw turned by means of a crank and bevel gears. As one turn of the crank raises or lowers the column ⅛ inch, the operator can quickly set the saw to any desired depth of cut without measuring.

The column supports a horizontal arm that is machined on the inside to receive a sliding block to which is attached the yoke and motor assembly. This horizontal arm may be swung around a complete circle, graduations enabling the operator to set the arm quickly for cutting at any angle. The motor may also be turned to the right or left and seated in four 90-degree positions for ripping parallel with the guide or at right angles to it. In addition to these adjustments, the motor is pivoted in the yoke and may be clamped in any position from the horizontal to the vertical,



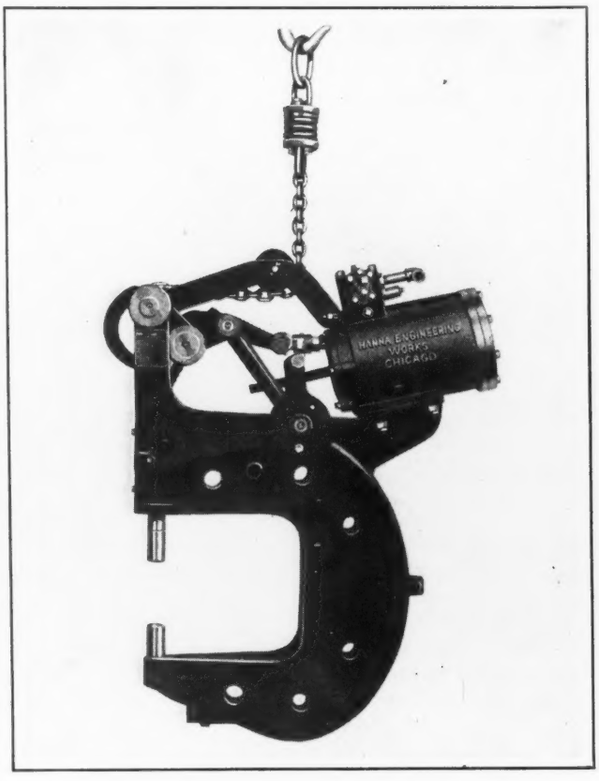
Woodworking Machine made by the De Walt Mfg. Co.

there being a means provided for quickly determining the horizontal, 45-degree, and vertical positions. The machine has a capacity for cutting boards up to 2 inches thick, and the weight is approximately 180 pounds.

PLUNGER SUSPENSION FOR HANNA RIVETERS

A plunger-suspension arrangement comprises a new accessory to the pneumatic riveting machines built by the Hanna Engineering Works, 1763 Elston Ave., Chicago, Ill. When riveters are equipped with this mechanism and suspended in the position illustrated, the upper die is stationary and the lower die movable. This permits "sticking" rivets from the top and driving from the bottom, which is said to result in a greater production for a given number of men. Rivets may be "stuck" far in advance of the machine, and continuous operation is not interrupted.

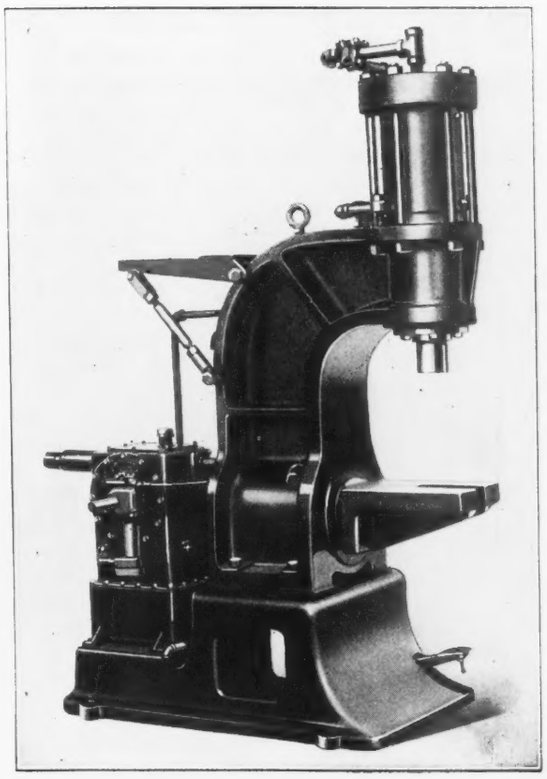
The suspension is made from the plunger by means of a chain which passes over a sheave on the upper toggle pin



Hanna Pneumatic Riveter equipped with Plunger Suspension

and under a sheave at the top of the machine, to the suspension hook. As the chain leaves the upper sheave, it is directly above the center of gravity of the riveter when the axis of the die screw is vertical. Operation of the mechanism to advance the plunger out of the frame barrel toward the lower die results in the entire frame being lifted, because the plunger cannot go down. The result is that the lower die rises and drives the rivet head from below. This suspension rigging is additional to and independent of the bale suspension, so that the riveter may be suspended by either method.

In the riveter illustrated is incorporated the Hanna mechanism which develops a predetermined pressure uniformly through the last half of the piston stroke or the last half inch of die travel. In 80-ton machines and over, the pressure is uniform for the last one inch of die travel. This portion of the die stroke performs the final or critical setting of the rivet. The earlier part of the stroke in which little actual work is done on the rivet is made at an average leverage between the piston and die of 2 to 1, as compared with 12 to 1 during the uniform-pressure portion of the stroke. Thus the dies are closed with a relatively small consumption of power, while the heading of the rivet is performed under known conditions.



Oilgear Hydraulic Riveter equipped with Constant-pressure Pump

OILGEAR HYDRAULIC RIVETER

A self-contained riveting machine of the hydraulic type has recently been developed by the Oilgear Co., 398 Thirty-eighth St., Milwaukee, Wis. This riveter can be driven from any constant-speed source of power, and is equipped with a type WE Oilgear constant-pressure pump. With this pump there is no delay in waiting for pressure to develop, as it is available the instant resistance is met. Oil is furnished to the cylinder under a steady pressure, free from pulsations and with an instantly variable delivery from zero to maximum.

The machine is controlled by a foot-treadle, so that the operator has full use of both hands for the work. The speed of the machine is limited only by the adeptness of the operator in placing rivets. In setting rivets by this method, each rivet is subjected to a quick squeeze, which causes the metal whether hot or cold, to assume the desired shape and make a tight joint without being unduly stressed or fractured. The stroke is 4 inches, and can be limited to just clear the work on the return movement. The horn shown in the illustration is of a special design to accommodate an indexing fixture, but removable horns of any design can be used. This riveter is built in two standard sizes—10 and 20 tons.

FORBES & MYERS TOOL GRINDER

The distinctive feature of the model 106 tool grinder recently brought out by Forbes & Myers, 178 Union St., Worcester, Mass., is the method of keeping the motor cool. The motor with which this grinder is equipped is of the fully enclosed dust-proof type, but the design is such that it has almost as great a power capacity as a motor of the open type with the same over-all dimensions. In the new motor design, as shown in Fig. 2, there are two fans located on the spindle just inside the bearings. These fans blow a current of air through the ends of the electrical windings surrounding them. After passing the windings, the air strikes the grinding wheel guards. By this construction, the heat of the motor is carried from the windings to the guards, and from the large area of the guards it is readily dispersed into the air of the room. The guards are made of aluminum, which is a good conductor of heat.

The motor was designed for this particular grinder without considering other applications, and for this reason it is longer but smaller in outside diameter than most motors. Its construction allows the wheels to project as far as possible in front of the motor. The motor is of ¾ horsepower capacity, of the squirrel-cage induction type, and is intended for two- or three-phase, 25-, 40-, or 60-cycle current of any voltage under 600. The spindle is provided with ball bearings. The wheels are 10 inches in diameter by 1½ inches thick, and run at 1800 R.P.M. on 60-cycle current.

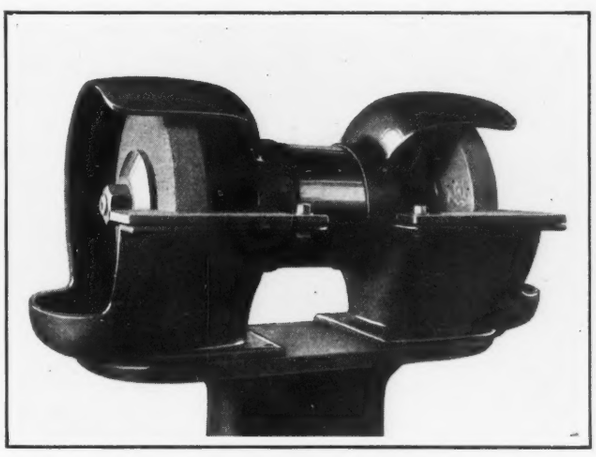


Fig. 1. Forbes & Myers Tool Grinder equipped with Special Fan-cooled Motor

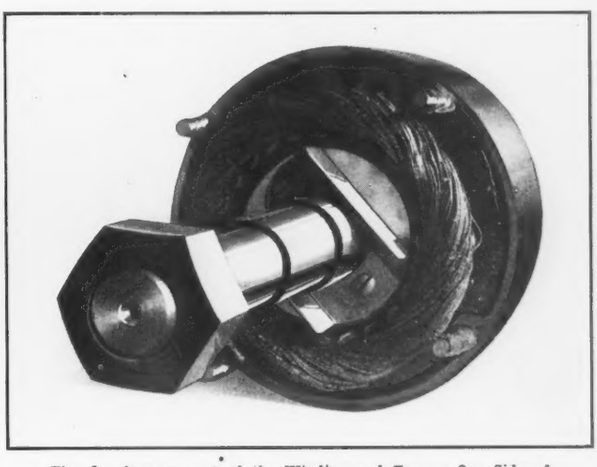
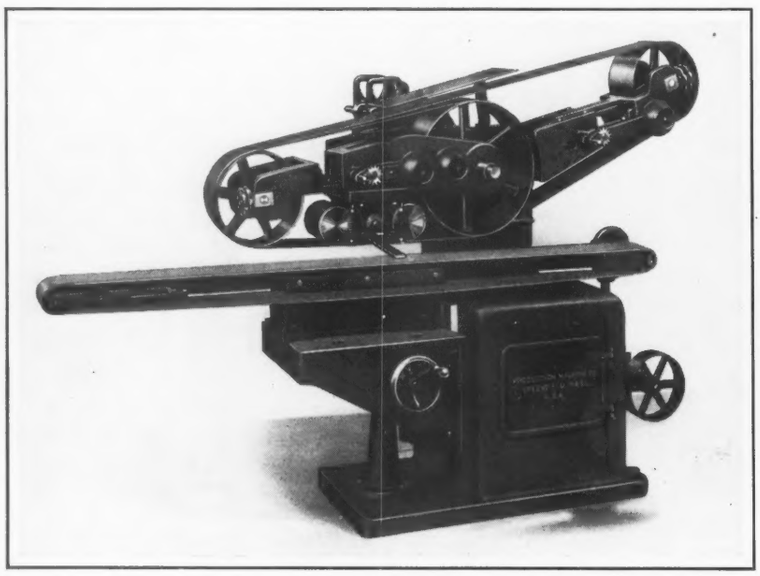


Fig. 2. Arrangement of the Winding and Fan on One Side of the Motor

PRODUCTION ABRASIVE FINISHING MACHINE

A type F high-speed polishing machine designed for finishing flat work has recently been developed by the Production Machine Co., Greenfield, Mass. In this machine, the work pieces are fed by power, being placed on the conveyor belt which carries them to the polishing position.



Production Type F High-speed Abrasive Finishing Machine

Here they are finished automatically, each piece being given the same degree of finish without any attention on the part of the operator other than keeping the machine loaded. The finished parts may automatically drop off the end of the conveyor into a box or chute or a second operator can be employed to unload them.

Work shorter than 6 inches may be laid on wooden blocks attached to the conveyor belt, which travels at 8 feet per minute. It is not necessary to clamp the work to the blocks, but pins should be provided for the work, to thrust against. For work longer than 6 inches, the wooden blocks are not attached to the conveyor belt, and in such cases the belt is provided with cleats against which the blocks may thrust. The table upon which the conveyor unit is mounted is quickly adjustable to suit different thicknesses of work. By means of this arrangement pieces ranging from 1/16 to 4 inches in thickness may be finished, the maximum width and length being 5½ and 18 inches, respectively. Hand fixtures can be used for polishing the flat surfaces of parts on which the base is pointed or which for other reasons cannot be handled to good advantage by means of the regular conveyor belt.

The machine is equipped with a leather cushion belt 109 inches long by 6 inches wide, and an abrasive belt 14 inches long by 6 inches wide. Compression grease cups are provided throughout so that all moving parts may be easily lubricated. The main bearings and the idler pulleys are equipped with floating bronze bushings. About 10 horsepower is required for operating the machine.

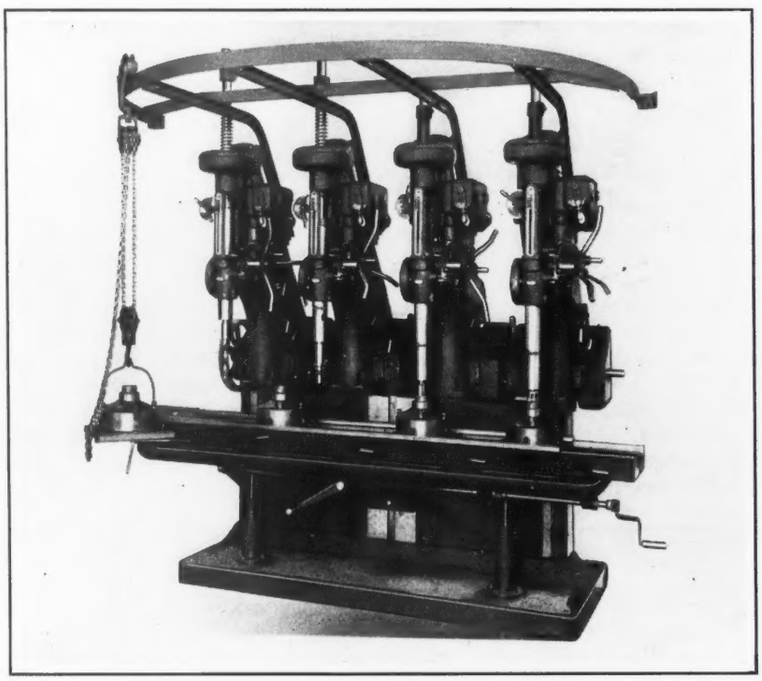
* * *

The world rarely takes off its hat to any man who didn't early take off his coat.—*National Lock News.*

HANDLING JIGS ON A GANG DRILL

When a series of operations is performed under the spindles of a gang drilling machine with the work held in jigs of some type that are pushed from spindle to spindle, the returning of the jigs to the starting spindle is frequently inconvenient, especially if the jigs are heavy. An installation is here illustrated in which the jigs are returned without any exertion on the part of the operator and with little loss of time. The machine is a four-spindle 24-inch self-oiling all-geared drilling machine built by the Barnes Drill Co., 814 Chestnut St., Rockford, Ill. The installation is used in machining a cast-iron bushing 7¼ inches long that is taper-bored from 1⅛ to 1¼ inches in diameter, and has two steps of larger diameters at the top end. The part is drilled, bored, faced, and rough- and finish-reamed at the rate of one piece every forty seconds, the machine being tended by one operator.

The sliding chuck jigs in which the work is held weigh about 70 pounds each, and so it was desirable to provide some easy means of returning the chucks to the starting end of the table after the work had been finished. Consequently, an overhead track was installed, on which were mounted a trolley and chain hoist. Each chuck is provided with a wire bail by means of which it is attached to the lower hook of the hoist when the operation is completed, and then conveyed to the left end of the table by simply pulling the trolley along the track.



Gang Drilling Machine equipped with Trolley and Hoist for handling Jigs

CONDITIONS IN THE SHIPBUILDING INDUSTRY

During 1923 a smaller tonnage of merchant vessels was launched in the shipyards of the world than in any year since 1915; and previous to 1915, only 1909 shows a smaller tonnage since 1897. The depression in the shipbuilding industry was primarily due to the tremendous tonnage launched in the four years 1918 to 1921, inclusive. In each of these years a tonnage double or more than double any previous annual tonnage was launched. In ocean-going vessels, the tonnage launched in the United States decreased from 2,348,000 tons in 1920 to 96,500 tons in 1923.

Questions and Answers

PRESSURE OF CAM ON ROLLER

G. O. F.—Can anyone tell of a simple method for calculating the pressure exerted by a uniformly accelerated cam surface against the roller in contact with it, when the torque of the cam driving shaft is known?

A simple solution to this problem is requested from MACHINERY'S readers.

DIES FOR HYDRAULIC BULGING

T. A. W.—In January, 1923, MACHINERY, an interesting method of hydraulic bulging and bending was described. I would like to know what metal is used for the dies employed in this method of forming sheet metals, and what pressures are generally required for this work.

A.—The dies can be made from ordinary tool steel with all surfaces polished and with lapped joints. They are hardened in the usual manner. The pressure varies with each job, and depends upon the kind of material, thickness, size, and form. From 16,000 to 25,000 pounds per square inch is the average pressure required. Generally it is necessary to experiment with each class of work performed, much the same as dies have to be experimented with when producing new shapes in the deep-drawing of metals.

STEEL FOR PERMANENT MAGNETS

A. E. P.—What is the best material for magnets of the permanent horseshoe type and what is the cheapest and best way of magnetizing them in large quantities?

A.—In high-grade magnets carbon and tungsten are generally considered the most important constituents. Manganese is found to reduce the capacity and should not be higher than 0.2 per cent. Silicon in small quantities is not detrimental and sulphur and phosphorus have no influence on the capacity or permanence of magnet steel. Copper and nickel are found to be detrimental and should be definitely excluded. Molybdenum may be used instead of tungsten.

During the last few years, considerable research work has been done in connection with high-grade magnet steels for magneto construction, in which the important element or elements are cobalt or chromium and cobalt. These alloys are characterized by exceptionally high values of coercive force and satisfactory values of remanent flux-density and other magnetic constants, and are capable of withstanding vibration, shock, and rough usage.

Honda, a Japanese investigator, gives the composition of a cobalt-tungsten-chromium steel for permanent magnets which has a coercive force approximately three times that of the best tungsten steel. The composition of this steel is given as from 0.4 to 0.8 per cent carbon, 5 to 9 per cent tungsten, 1.5 to 3 per cent chromium, and from 30 to 40 per cent cobalt. The hardening temperature of this metal is about 1740 degrees F. A German authority, Gumlich, gives the composition of a magnet steel as 1.13 per cent carbon and 6 per cent chromium. This steel is hardened at a temperature of about 1650 degrees F. What may be called a typical tungsten steel may have 0.62 per cent carbon, 5.7 per cent tungsten, 0.09 per cent silicon and 0.55 per cent manganese with a hardening temperature of about 1600 degrees F. A similar steel which has given good results contains 0.60 per cent carbon, 5.37 per cent tungsten, 0.25 per cent silicon, and 0.18 per cent manganese. The hardening temperature of this steel is about 1560 degrees F.

According to a paper read by W. Brown, before the Royal Dublin Society in 1920, it would appear that chromium steels are less susceptible to decay or loss of magnetism than other steels. A number of magnets of varying composition that had been laid aside for ten years were tested, and the most retentive were found to be magnets with approximately 1 per cent of carbon and 3 per cent of chromium. The manganese group had lost some 25 per cent, and the tungsten group approximately 20 per cent of their magnetism.

According to an English correspondent, two well-known British makers of tungsten magnet steel are Watson, Saville & Co., Ltd., Sheffield, and Peter Stubbs, Ltd., Warrington. The magnet steel sold by these firms has from 5 to 6 per cent tungsten, 0.5 to 0.75 per cent carbon, and not more than 0.04 per cent phosphorus, 0.04 per cent sulphur, 0.1 per cent silicon, and 0.4 per cent manganese.

The process of magnetizing is a simple and quick one. The solenoid method is the most satisfactory, and provided the air gap allows sufficient clearance for the solenoids, magnetizing may be effected in approximately half a minute. The solenoids consist of a spool or shell with windings and insulating covering very similar to the coils of an electric bell magnet. While the magnet is being magnetized, the current is rapidly interrupted and the magnet hammered with a rawhide mallet to cause the magnetic molecules to adjust themselves properly. If it is impossible to utilize solenoids, the magnetizing may be effected by means of electromagnets. Bending, hardening, and grinding precede the magnetizing operation, after which the magnet should be aged by prolonged heating in boiling water or steam.

HOW CAN BLUEPRINTS BE MADE TO ADHERE TO CELLULOID?

H. J. H.—If any reader of MACHINERY has been successful in developing a method for making blueprints adhere to celluloid, a detailed description of this method would be appreciated. The writer has tried glue, but when it dries it does not adhere to the celluloid. Shellac, when dry, cracks and also makes the celluloid curl.

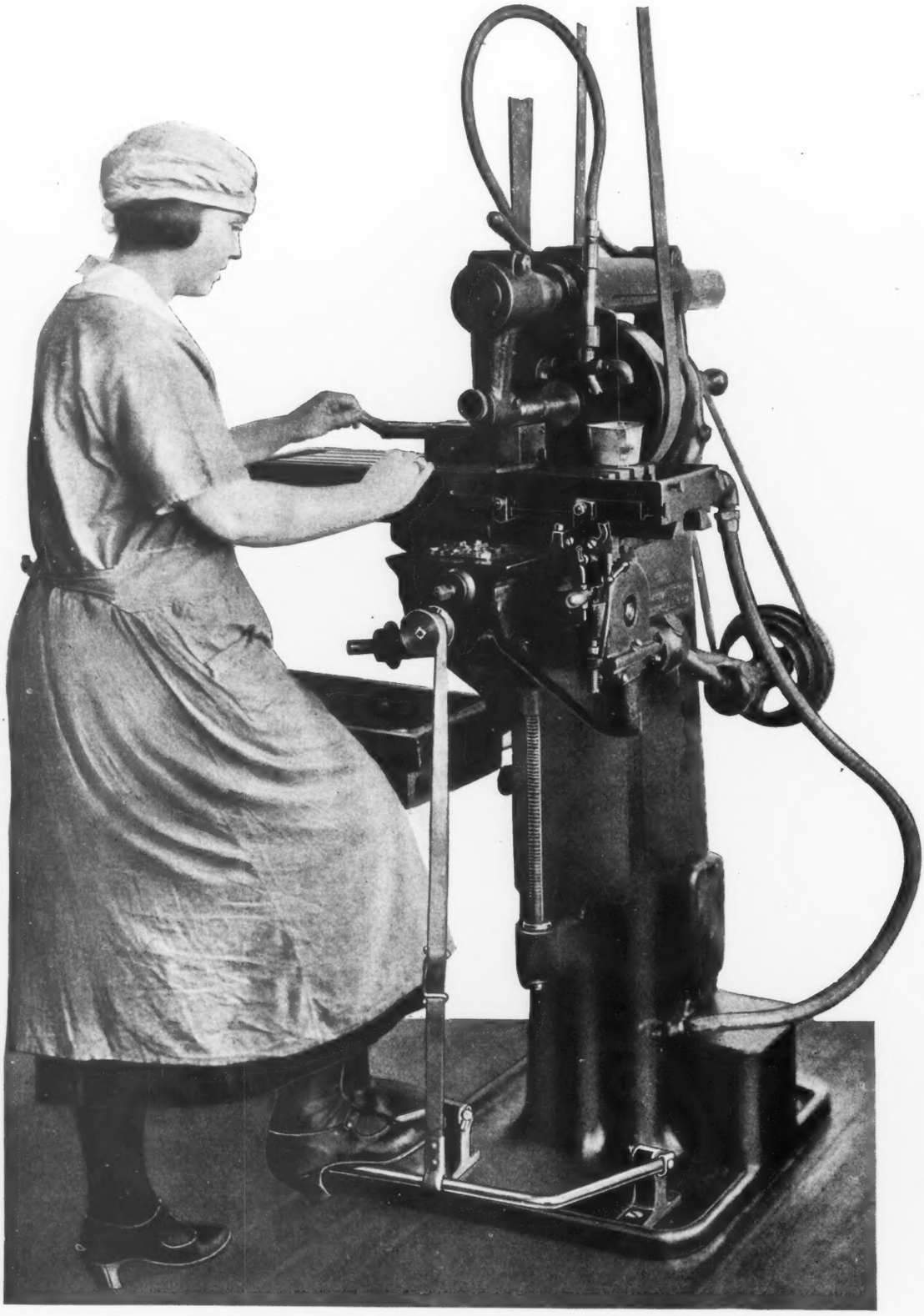
CAN A SIMILAR COMPETING TRADE-MARK BE CANCELLED?

H. P. Co., Inc.—We have lately had our attention called to a trademark issued by the U. S. Patent Office, for use on a line of goods similar to that of our manufacture. This trademark is so similar to the one that has been employed by us for a number of years to distinguish our product from that of another that we believe we will be seriously injured by the issuance of this trademark and its use by a competitor. What redress have we, if any?

ANSWERED BY GLENN B. HARRIS, YONKERS, N. Y.

There are several lines of action open to you. It would seem advisable that you make an application to the Commissioner of Patents for the cancellation of the new trademark. A suitable form will be furnished by the Patent Office upon application. The request for cancellation may be made at any time, but it is desirable that it be made as soon as possible after the discovery of the competing trademark. If it should appear, after a hearing, that the registrant was not entitled to the use of the mark at the time of his making the application for registration, the grant will be cancelled. If, as you state, the conflicting mark is so similar in appearance to yours as to be calculated to deceive the public, there would hardly be any doubt that a decision would be rendered in favor of your company.

"STEP ON IT"—



and increase your production with this attachment

Convert your Brown & Sharpe OY Plain Milling Machine into a semi-automatic machine that will increase your production 20% or more. It's a simple device, easily attached to any one of these machines without extensive fitting.

Load the fixture, step on the treadle and the attachment does the rest. Stepping on the treadle advances the table and the engagement of cutting feed and return of table are entirely automatic.

IT REDUCES operator's fatigue—saves 3 hand motions. Here's how

Without Attachment the hands must	*With Attachment the hands have only to*
1 Load	**1 Load**
2 Advance table	**2 Unload**
3 Engage cutting feed	
4 Return table	
5 Unload	

DOUBLES PRODUCTION where the loading time is shorter than the cutting time as the operator can easily run two machines. And the operator experiences less fatigue running two machines, so equipped, than one hand-operated machine. There's nothing for the operator to do, but load and unload the fixture and "step on it."

ALSO, it is impossible for the operator to jam the work into the cutters. It saves breaking cutter teeth and facilitates training new operators. These are two important factors that help reduce your operating costs.

If you are interested in increasing your production on light milled pieces, get in touch with our engineers and with this simple little attachment they will show you how to save time and money.

This folder describes the attachment in detail and shows some examples of increased production that will interest you. Ask for it when you write.

BROWN & SHARPE MFG. CO.

PROVIDENCE, R. I., U. S. A.

PERSONALS

H. E. GALVIN, second vice-president and manager of the Buffalo office of the Ogden R. Adams Co., Inc., has become associated with Crane-Schiefer-Owens, Inc., Buffalo, N. Y., as sales engineer.

J. H. CHAPLIN, vice-president and director of sales of the Root Co., Bristol, Conn., recently sailed for England, where he will look after the details of some large installations of Root automatic counters.

E. A. WURSTER, secretary and treasurer of the Falk Corporation, Milwaukee, Wis., has retired and will be succeeded by CLARENCE R. FALK. Mr. Wurster has been connected with this company since its inception.

R. K. LEBLOND, president of the R. K. LeBlond Machine Tool Co., Cincinnati, Ohio, was elected chairman of the board of directors of the Niles-Bement-Pond Co., 111 Broadway, New York City, at the annual meeting of the company.

HOWARD MACNEAL, formerly of the Philadelphia plant of the Link-Belt Co., Chicago, Ill., has been transferred to the Chicago works, where he will be engaged in the promotion of portable loaders, portable belt conveyors, and electric hoists.

CLYDE WISENBURGH, formerly sales representative of the Standard Bearings & Equipment Co., Plainfield, N. J., has become associated with the sales organization of the U. S. Ball Bearing Mfg. Co., Chicago, Ill., manufacturer of Strom ball bearings.

W. H. PATTERSON has joined the John H. Dunham Co., Wrigley Bldg., Chicago, Ill., an advertising agency, as vice-president. Mr. Patterson was formerly associated with the Westinghouse Electric & Mfg. Co. as manager of the resale-industrial sales department.

JOHN E. COBAUGH has been appointed sales representative in Philadelphia and the surrounding territory for the H. J. Ness Mfg. Co., 48 Howard St., New York City. Mr. Cobaugh will have charge of the sale of the Nessweld spot welder. His headquarters are in the Stephen Girard Bldg., 21 S. 12th St., Philadelphia, Pa.

C. S. HUNTINGTON, sales engineer in charge of the sand and gravel washing division of the Link-Belt Co., Chicago, Ill., will now look after the interests of the company in the cement industry in addition to his regular duties. Mr. Huntington will continue to make his headquarters in Chicago at 910 S. Michigan Ave.

A. L. RALSTON, who has been connected with the Crucible Steel Co. of America for over twenty-two years, is now sales manager of the Braeburn Alloy Steel Corporation, Braeburn, Pa. He served the Crucible Steel Co. of America as Pittsburg district manager, assistant general sales agent, and for the last two years as Detroit district manager.

CHARLES EISLER of the Eisler Engineering Co., Newark, N. J., sailed on the *Rochambeau*, February 20, for an extensive business trip to Europe. During his stay abroad he will visit the principal cities of the Continent and will spend some time at the Foire de Lyon where a large number of Eisler lamp-making machines will be exhibited.

E. F. W. ALEXANDERSON, consulting engineer of the General Electric Co., Schenectady, N. Y., and chief consulting engineer of the Radio Corporation of America, has been awarded the order of the Polonia Restituta by the Polish Government in recognition of his meritorious services in connection with the building of Poland's new radio station near Warsaw.

J. H. ROBERTS has been appointed eastern manager of sales by the Vanadium-Alloys Steel Co., Latrobe, Pa. Mr. Roberts will make his headquarters at 143 Liberty St., New York City. Until recently, he was vice-president of the Atlas Steel Corporation, and has had a wide experience in the executive, manufacturing, and metallurgical departments of the tool and special alloy steel industry.

PROFESSOR FRED CRABTREE, head of the department of metallurgical and mining engineering at the Carnegie Institute of Technology, Pittsburg, Pa., has been elected president of the Engineers' Society of Western Pennsylvania. Professor Crabtree was graduated from the Massachusetts Institute of Technology in 1889. He has been connected with the faculty at the Carnegie Institute since 1906.

FRED K. RAND, for nineteen years superintendent of the machinery division of the National Acme Co., at Cleveland, Ohio, and for twenty-five years associated with the company, has retired from active service. Mr. Rand entered the employ of the company when it was known as the Acme Machine Screw Co. of Hartford, Conn., and has been with the company ever since. He plans to leave for California with his family early in March for an extended rest.

S. E. DIBBLE, head of the department of heating, ventilating and sanitation at the Carnegie Institute of Technology, Pittsburg, Pa., has been elected first vice-president of the American Society of Heating and Ventilating Engineers. Mr. Dibble has served for six years on the committee on research which is conducting studies in heating and ventilating problems at the Pittsburg Station of the United States Bureau of Mines in cooperation with the Carnegie Institute.

PROFESSOR ELIHU THOMSON, one of the founders of the General Electric Co., and among the world's most eminent electrical engineers, has been awarded the Lord Kelvin gold medal, and will go to England next summer to receive it. This medal is awarded every three years as a mark of distinction and for excellence in original research work in engineering. Professor Thomson is the first American to receive this honor. The award was made jointly by the British and American engineering societies. Professor Thomson has also been honored with the degree of Doctor of Laws by the University of Pennsylvania.

F. H. VOSE, head of the Department of Mechanical Engineering at the Case School of Applied Science, has been placed in charge of a new department devoted to problems of power and fuel which has recently been organized by the George T. Trundle, Jr., Engineering Co., Cleveland, Ohio. Professor Vose has been specializing for eleven years in practical power plant engineering, economical use of fuel, utilization of waste heat, and application of waste heat boilers. During the war he was a consultant with the Fuel Administration. Previous to his connection with the Case School, he was associated with the United States Bureau of Mines and with Washington University.

WILLIAM GAERTNER, president of the Gaertner Scientific Corporation, 1201 Wrightwood Ave., Chicago, Ill., has been awarded the Howard N. Potts gold medal by the Franklin Institute acting through its Committee of Science and Arts. This medal was awarded to Mr. Gaertner "in consideration of his notable achievements as a designer and maker of scientific instruments, materially contributing to the success of the research in physical science." Mr. Gaertner, for twenty-eight years, has been the sole proprietor of Wm. Gaertner & Co., makers of scientific instruments, formerly located at 5345 Lake Park Ave., and at present he is the head of the Gaertner Scientific Corporation. He is recognized as one of the foremost scientific instrument makers in the United States, and is given credit for having emancipated American educational and scientific institutions from their dependence on foreign-made scientific instruments.

OBITUARIES

W. W. TOTMAN, field representative during the last twenty years for the Whitney Mfg. Co., Hartford, Conn., died at the Hartford Hospital on February 7. Before becoming connected with the Whitney Mfg. Co. he obtained valuable mechanical experience with the Pratt & Whitney Co., Boston Gear Works, and Fellows Gear Shaper Co., and became one of the best-known sales representatives in the automotive industry.

EDWARD DEAN, general superintendent of the Century Electric Co., St. Louis, Mo., for the last eighteen years, was struck by a motorcycle on January 25 and died from resulting injuries. Mr. Dean was fifty-seven years of age, and was a native of Michigan. Besides being superintendent, he was a vice-president of the Century Electric Co. and one of the directors of the company, and was also a member of the American Society of Mechanical Engineers and the St. Louis Engineers' Club.

HOMER B. BELFIELD, for fifteen years purchasing agent with the Billings & Spencer Co., of Hartford, Conn., died January 14 in the Hartford Hospital. Mr. Belfield had been taken to the hospital to be operated on for appendicitis and three days later was operated on again for peritonitis. Heart complications aggravated his condition, and he died shortly after the second operation. Mr. Belfield was born in Southbury, Conn., November 8, 1866. He had been associated with the Billings & Spencer Co. for twenty-eight years. He was a member of the Purchasing Agents' Association of Hartford County and served as its president in 1920. Mr. Belfield was also prominent in Masonic circles.

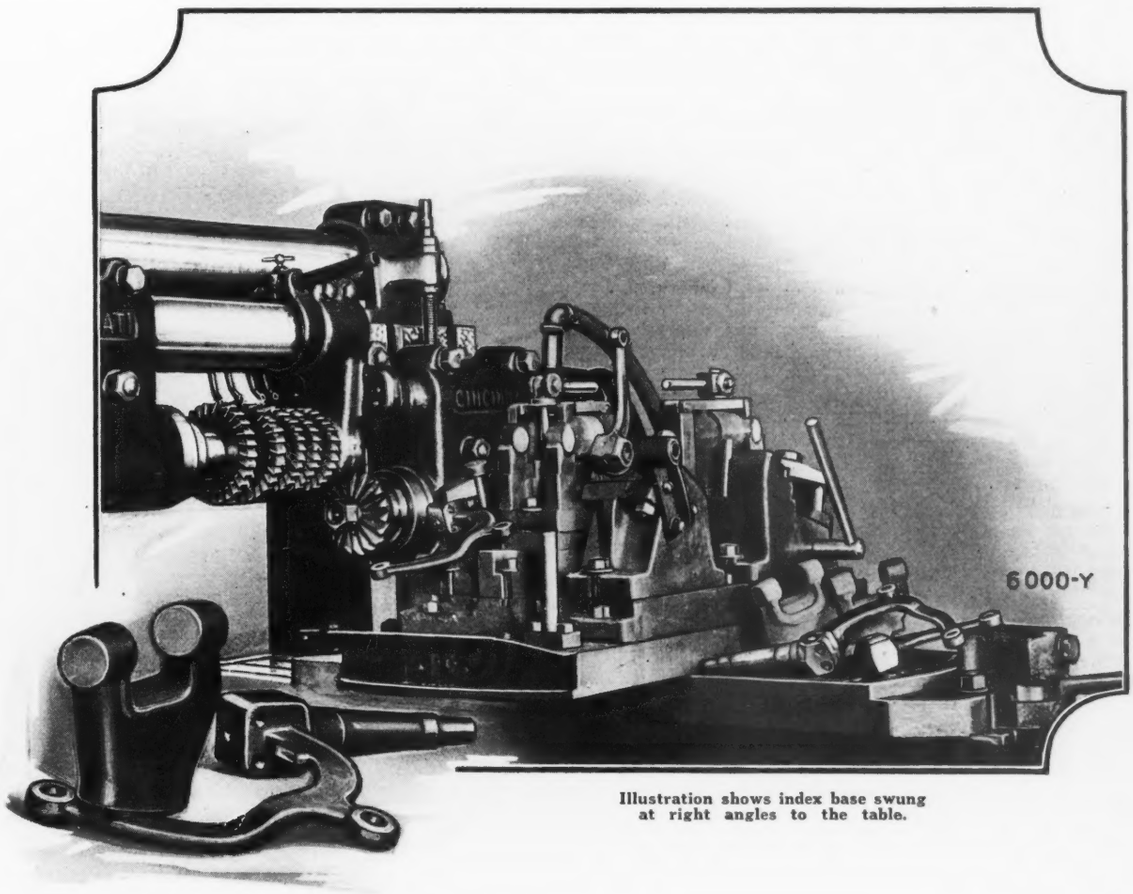


Illustration shows index base swung at right angles to the table.

At Franklin's—
They cut the time from 9 minutes to 3½ minutes

By changing to a Standard 48″ Duplex Automatic Cincinnati Miller, and combining three operations, the H. H. Franklin Automobile Company has obtained a saving of 5½ minutes on milling of yokes and steering knuckles.

Use our Engineering Service—We are especially qualified to assist automobile manufacturers as a result of our intimate and extensive experience in the automobile field, where we have been rendering this high production service for the last eleven years.

Let us show you what savings we can make on *your* work. Call our Milling Specialist for a personal survey of your job. Have our thoroughly experienced Engineers, at our plant, submit recommendations including sketches and time studies—a complete estimate.

1924 will demand lower production costs. *Call on us to help you.*

Send for complete catalogue.

THE CINCINNATI MILLING MACHINE COMPANY
CINCINNATI *Established 1884* **OHIO, U. S. A.**

CINCINNATI MILLERS

TRADE NOTES

KASENIT CO., manufacturer of open-hearth casehardening compounds, has removed its office to 2-4 Stone St., New York City.

WARREN, WEBSTER & CO., Camden, N. J., manufacturers of steam heating systems, feed-water heaters, and steam specialties, have moved into their new plant at Federal and 17th Sts., Camden.

CENTURY ELECTRIC CO., St. Louis, Mo., manufacturer of various types of motors, announces that it is now in a position to furnish its type SC motors in sizes up to and including 50 horsepower.

SAN-EKI SHOTEN, No. 13 Gorobeicho Kyobashiku, Tokyo, Japan, would like to obtain catalogues and circulars from manufacturers of power presses, shears, rolls, and hydraulic presses, as the fire following the earthquake has completely destroyed all their literature.

B. C. AMES CO., Waltham, Mass., manufacturer of dial gages, bench lathes, and precision tools, announces that the Ames No. 55 dial gage, which was described in the March, 1923, number of MACHINERY, is now provided with a new feature in the form of a bezel lock.

UNIT MOTOR CO., Kansas City, Mo., expects to move from 2615 Walnut St., into new headquarters at the northwest corner of 14th and Chestnut Sts., Kansas City, on April 1. The new factory will give additional scope for expansion and for the installation of heavy machinery.

ERRINGTON MECHANICAL LABORATORY of New York has opened a direct Chicago branch at 612 W. Adams St., under the management of Paul A. Koerber. At the Chicago office a full line of tapping, screw-cutting, and stud-, nut-, and screw-driving tools will be on exhibition for demonstration purposes.

WEINER ENGINEERING CO., Cleveland, Ohio, has sold its entire interests to the RESERVE MACHINE CO., located at 10101 Quincy Ave., Cleveland, Ohio. The officers of the latter concern are as follows: President and general manager, H. E. Elliott; works manager, R. T. Elliott. The company will engage in machine contract work and specialize in a line of production tools.

AMERICAN MANUFACTURERS' FOREIGN CREDIT UNDERWRITERS, 130 William St., New York City, is a cooperative association built up through membership of exporters, and consisting of approximately 900 members. It is practically a mutual insurance association, the fundamental purpose of which is to insure the credit of foreign buyers. At the present time, it is stated, the files of this association carries trade and credit information on approximately 180,000 foreign importers.

ALBAUGH-DOVER CO., 2100 Marshall Blvd., Chicago, Ill., manufacturer of gears and cream separators, has been reorganized by a syndicate composed of former stockholders and bond holders, who have purchased the entire assets of the company. The name of the company has been changed to the ALBAUGH-DOVER MFG. CO. F. G. Eppley who has been in charge of the manufacturing departments of the company for seventeen years, will continue in charge of these departments.

CARBORUNDUM CO., Niagara Falls, N. Y., manufacturer of abrasive and refractory materials, has completed plans for the erection of a new administration and office building, which, with equipment, will cost approximately $300,000. The structure will be built on Buffalo Ave. near the buildings of the Niagara Falls Power Co. on a plot of land 394 by 217 feet. The building itself will be 200 feet long and 62 feet deep, three stories and basement. Work will be started at once, and the building will be completed and ready for occupancy late in the fall.

PAWLING & HARNISCHFEGER CO., Milwaukee, Wis., manufacturer of machine tools, excavators, and cranes, has recently opened new offices in the South at Memphis, Tenn., and Dallas, Texas. H. B. Norris, formerly district manager at New Orleans, is district manager of the Memphis office; D. J. Murphy, also formerly at the New Orleans office, is district manager of the Texas district; with headquarters at Dallas; and F. W. Truex continues as district manager at Atlanta, Ga., with offices at 212 Hass-Howell Bldg. W. J. Dugan, as southern sales manager, will assume charge of the entire southern territory, with headquarters at Memphis.

SENECA FALLS MFG. CO., INC., 381 Fall St., Seneca Falls, N. Y., manufacturer of "Star" engine lathes and "Short-cut" lathes, has been acquired by Marcus A. Coolidge of Fitchburg, Mass., and is now operated by the same interests that own the Fitchburg Machine Works, Fitchburg, Mass. Up to a few years ago Mr. Coolidge owned the Seneca Falls Mfg. Co., which he has now again acquired. The company will continue to manufacture the "Star" engine lathes and "Star Short-cut" production lathes, and will, as soon as practicable, add other lines of machine tools. All of the old employes have again entered the employ of the company, which will insure the same workmanship as in the past.

NILES-BEMENT-POND CO., 111 Broadway, New York City, at its recent annual meeting, elected officers and directors as follows: R. K. LeBlond was elected chairman of the board of directors; James K. Cullen was elected president; Charles L. Cornell and Sandford G. Etherington, vice-presidents; John B. Cornell, treasurer; Charles Stuart Guthrie, secretary; and E. Jay Edwards, Jr., assistant secretary and treasurer. The following were re-elected directors: James K. Cullen, Charles L. Cornell, John B. Cornell, Henry Bertram, Fred W. Gordon, and Sandford G. Etherington. The new directors elected to fill vacancies are: Richard K. LeBlond, Gordon Rentschler, Lucius Rossiter, Edward L. Leeds, Charles K. Seymour, and George Warrington.

PHILADELPHIA GEAR WORKS, 1120 Vine St., Philadelphia, Pa., in cooperation with their employes, have taken out group insurance covering the lives of the employes, the insurance policies ranging from $1000 to $2500, according to the class of work. In addition there is provided a benefit of $12 per week for accidents outside the plant or for illness, accidents occurring while at work being compensated for under the Pennsylvania Workmen's Compensation Law at the expense of the company. Any employe who is insured and who becomes totally and permanently disabled before reaching the age of sixty will receive the full amount of insurance in monthly installments of $51 for twenty months. New employes are eligible for the insurance after they have been with the company for six months.

COMING EVENTS

APRIL 23-24—Twenty-sixth annual convention of the National Metal Trades Association in New York City; headquarters, Hotel Astor. National secretary, L. W. Fischer, Peoples Gas Bldg., Chicago, Ill.

APRIL 28-30—Annual meeting of the American Gear Manufacturers' Association at Buffalo, N. Y. Secretary, T. W. Owen, Room 107, 2443 Prospect Ave., Cleveland, Ohio.

APRIL 30-MAY 2—Eleventh convention of the Society of Industrial Engineers in Buffalo, N. Y. Executive secretary, George C. Dent, 608 S. Dearborn St., Chicago, Ill.

MAY 19-21—Joint convention of the Southern Supply and Machinery Dealers' Association, the National Supply and Machinery Dealers' Association, and the American Supply and Machinery Manufacturers' Association, in Cleveland, Ohio; headquarters, Hotel Cleveland. Secretary-treasurer, F. D. Mitchell, 1819 Broadway, New York City.

MAY 26-29—(instead of 19-22)—Spring meeting of the American Society of Mechanical Engineers at Cleveland, Ohio. Calvin W. Rice, secretary, 29 W. 39th St., New York City.

JUNE 4-6—Eleventh annual foreign trade convention in Boston, Mass. O. K. Davis, India House, Hanover Square, New York City, secretary.

JUNE 11-18—Convention and exhibit of Section V Mechanical, of the American Railway Association in Atlantic City, N. J. Secretary, V. R. Hawthorne, 431 S. Dearborn St., Chicago.

JUNE 11-18—Convention and exhibit of the Railway Supply Manufacturers' Association in Atlantic City, N. J. Secretary, J. D. Conway, 1841 Oliver Bldg., Pittsburg, Pa.

JUNE 23-27—Twenty-seventh annual meeting of the American Society for Testing Materials, in Atlantic City, N. J.; headquarters, Chalfonte-Haddon Hall Hotel. C. L. Warwick, secretary-treasurer, 1315 Spruce St., Philadelphia, Pa.

JUNE 30-JULY 12—World power conference in London, England, at the British Empire Exhibition, in cooperation with technical and scientific institutes and industrial organizations. Further information may be obtained from Calvin W. Rice, secretary of the American Society of Mechanical Engineers, 29 W. 39th St., New York City.

NEW BOOKS AND PAMPHLETS

MECHANICAL WORLD YEAR BOOK FOR 1924. 348 pages, 4 by 6 inches. Published by Emmott & Co., Ltd., 65 King St., Manchester, England. Price, 1/6.

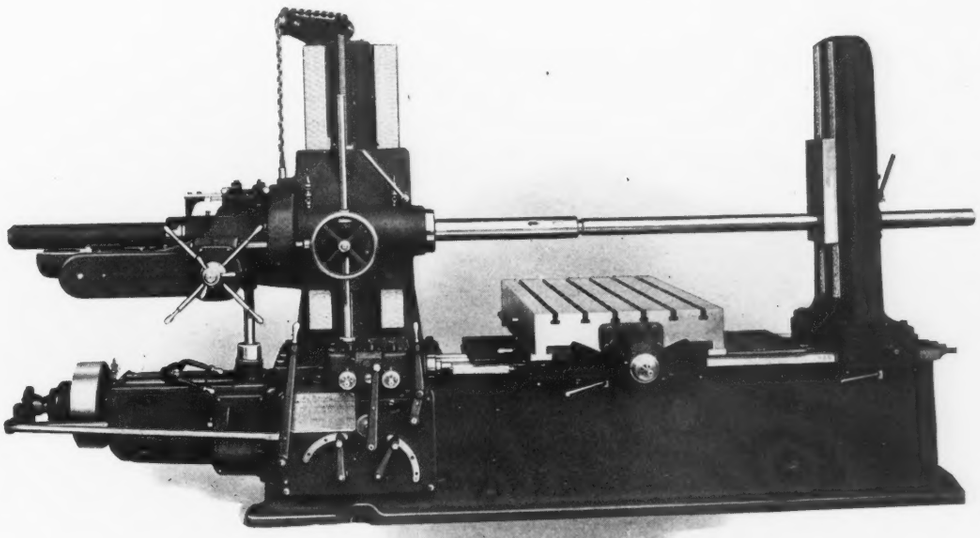
This well-known little handbook has reached the thirty-seventh year of its publication. The present edition contains some new material, including a section on the combustion of fuel, and a section on the strength of flat plates, giving various rules for determining the strength of rectangular, square, and circular plates. A section has also been added on tanks, dealing with the thickness, capacities, riveting of tanks, etc. Various revisions have been made in the body of the work.

NEW CATALOGUES AND CIRCULARS

UNIVERSITY OF MISSOURI, Rolla, Mo. Bulletin of the School of Mines and Metallurgy for October, 1923, containing register of graduates from 1871 to 1923.

CONSOLIDATED TOOL WORKS, INC., 296 Broadway, New York City. Circular illustrating the "Pilot" No. 12 hand drill, having a capacity up to 5/32 inch.

"It is easy enough to be wise after the event"



One customer who hesitated for considerable time because he thought he "wouldn't be able to keep it running" found so many customers who wanted their work done on a

"PRECISION"

Boring, Drilling and MILLING MACHINE

that he had to buy another and larger one.

WE ALSO MAKE THE

LUCAS POWER Forcing Press

LUCAS MACHINE TOOL CO. NOW AND ALWAYS OF **CLEVELAND, OHIO, U.S.A.**

FOREIGN AGENTS: Alfred Herbert, Ltd., Coventry. Societe Anonyme Belge, Alfred Herbert, Brussels. Allied Machinery Co., Turin, Barcelona, Zurich, V. Lowener, Copenhagen, Christiania, Stockholm. R. S. Stokvis & Zonen, Paris and Rotterdam. Andrews & George Co., Tokyo.

C. H. COWDREY MACHINE WORKS, Fitchburg, Mass. Circular showing examples of a few of the different types of special machines produced by this concern.

NORTON CO., Worcester, Mass., is issuing a monthly publication entitled "Norton Floors," devoted to a description of different applications of Norton alundum slip-proof floors.

PANGBORN CORPORATION, Hagerstown, Md. Circular descriptive of the sand-blast equipment made by this concern, including hose machines, cabinets, barrels, and rotary tables.

AMERICAN SOLE & BELTING LEATHER TANNERS, INC., 17 Battery Place, New York City. Booklet containing a brief history of leather and a description of the tanning process.

ADAMS CO., 1910 Market St., Dubuque, Iowa. Supplement A to catalogue 30, descriptive of the general construction of Adams air squeezers, which are made in both stationary and portable types.

ROLLER-SMITH CO., 233 Broadway, New York City. Bulletin 210, descriptive of Roller-Smith direct-current portable electrical measuring instruments, including ammeters, voltmeters, galvanometers, etc.

BAIRD MACHINE CO., Bridgeport, Conn. Pamphlet entitled "Ways of Cutting Costs of Production," illustrating Baird four-slide wire-forming machine, 6 by 6 six-spindle horizontal chucking machine, and tumblers.

GRISCOM-RUSSELL CO., 90 West St., New York City. Bulletin 1216, illustrating and describing the U-Fin air cooler, which is used for cooling the air from generating windings by the use of turbine condensate.

METALWOOD MFG. CO., Leib and Wight Sts., Detroit, Mich. Circular illustrating the latest "Metalwood" development in high-speed hydraulic press design—a machine particularly adapted for broaching operations.

LUFKIN RULE CO., Saginaw, Mich. Catalogue 2, containing specifications and prices covering the line of small tools made by this concern, including rules, thickness gages, squares, dividers, micrometers, etc.

NATIONAL LOCK CO., Rockford, Ill. Bulletin 8, of steel cap-screws, set-screws, machine screws, stove and carriage bolts and nuts, wood screws, etc., containing tables of dimensions and list prices of the various sizes and types.

READY TOOL CO., 650 Railroad Ave., Bridgeport, Conn. Tool catalogue 20, showing the principal "Red-E" tools, including lathe tools, shaper and planer tools, threading tools, cutting-off tools, lathe centers, dogs, etc.

JOLITE TOOL CO., 610 Sycamore St., Milwaukee, Wis. Pamphlet containing instructions relating to the use of Jolite tools—tools which have been subjected to a process that produces a thin protecting shell of high-production cutting material around the steel.

S. F. BOWSER & CO., INC., Fort Wayne, Ind. Catalogue of Bowser gasoline storage and distributing equipment, containing illustrations and specifications of oil and gasoline pumps, agitator tanks, storage tanks, rotary pumps, oiling and filtering systems, etc.

DURIRON CO., Dayton, Ohio. Catalogue of "Duriron," containing a description of this acid-resistant metal, and of the apparatus and equipment produced from it, including pumps, ejectors, steam jets, pipe and fittings, exhaust and ventilating fans, cocks and valves, etc.

L. J. WING MFG. CO., 352 W. 13th St., New York City. Folder descriptive of the Wing "Featherweight" unit heater, the important features of which are small dimensions, compactness, and light weight. Full details concerning sizes and other engineering data are given.

NEW DEPARTURE MFG. CO., Bristol, Conn. Loose-leaf circular 13FE, dealing with ball bearing mounting practice, and containing charts showing the expansion of the inner ball raceway due to mounting fits. Tables are included giving the recommended diameters of housings and shafts.

HISEY-WOLF MACHINE CO., Cincinnati, Ohio. Bulletin 3016-S, illustrating and describing the new Hisey motor-driven wide-swing floor-stand grinder, the design of which permits the wheels to be spaced 37 inches apart to accommodate large, bulky castings and other irregular shaped pieces.

INGERSOLL MILLING MACHINE CO., Rockford, Ill. Folder illustrating the different types of machines that have been built by this company during 1923, among which are included special single- and multiple-spindle milling, boring and drilling machines for automotive, railway, and general production work.

CROUSE-HINDS CO., Syracuse, N. Y. Folder No. 9, illustrating Crouse-Hinds safety panels and cabinets, which are designed to promote unrestricted operation of the circuit switches without the possibility of the operator coming in contact with any live parts. Bulletin 2054, containing price lists of condulets of the FA series.

INDEPENDENT PNEUMATIC TOOL CO., 600 W. Jackson Blvd., Chicago, Ill. Pamphlet descriptive of the "Thor" quick interchangeable electric drill, size UDK. Although designed especially for use in building cars, this drill is also applicable to general production work, for drilling and driving screws, bolts, studs, etc.

HOSKINS MFG. CO., 4437 Lawton Ave., Detroit, Mich. Circular illustrating and describing the Hoskins electric pusher furnace, which has been designed for automatically heat-treating small parts of such shape that they can be used to push each other along a suitable groove or through a tube, as, for example, wrist-pins and spring bolts.

NATIONAL ELECTRIC MFG. CO., 600 Chatfield & Woods Bldg., Pittsburg, Pa. Circular describing the "Syntron" electric hammer for use in hammering, drilling, chipping, cutting, vibrating, and riveting. The circular gives data on the operating cost, power, and various features of construction, as well as the results of tests that have been made with this hammer.

ROCKFORD TOOL CO., 2400 Eleventh St., Rockford, Ill. Catalogue of the Sundstrand "Stub" lathe, a general-purpose production machine. The various features of construction are described in detail, and specifications are given. Illustrations are included showing different typical jobs requiring multiple operations that can be handled on this machine, together with the tooling lay-outs.

CHARLES H. BESLY & CO., 120-B N. Clinton St., Chicago, Ill. Catalogue of Besly "Titan" abrasive disks, outlining the characteristics of these disks and listing the work for which they are especially suitable. Production figures are given for specific jobs. Detailed instructions concerning the use of "Titan" disks are included, and a number of letters of recommendation are reproduced.

MACWHYTE CO., Kenosha, Wis. Catalogue of Macwhyte wire rope, containing a brief description of wire rope, its method of manufacture, materials used, various constructions and qualities, as well as general information concerning its use, such as directions for attaching sockets to wire rope, directions for splicing wire rope, lubrication, tables showing comparative life of ropes when used on drums of different diameters.

SOUTH BEND LATHE WORKS, 666 E. Madison St., South Bend, Ind. Bulletin 7, containing illustrations of fifty-two typical jobs performed on South Bend lathes in the automobile repair shop, garage, machine shop, and battery service and ignition stations. Bulletin 9, containing fifty-two illustrations showing the adaptability and application of South Bend lathes on all-around work in the tool-room, machine shop, and metal-working industry in general.

WESTINGHOUSE ELECTRIC & MFG. CO., Pittsburg, Pa. Circular 1664, entitled "Indicating Instruments for Direct and Alternating Currents." The catalogue includes a brief outline of the development of electricity, with special reference to alternating current and the earlier alternating-current instruments. It also discusses the principles of operating these instruments and describes in detail the various parts. The last chapter is devoted to instrument applications.

KEARNEY & TRECKER CORPORATION, Milwaukee, Wis. Catalogue entitled "Production Service," outlining the company's production service policy, which constitutes the designing and building of special attachments for application to standard Milwaukee milling machines. The catalogue shows different special attachments designed and built by the K. & T. Production Service, engaged on a wide variety of work, and contains detailed instructions for obtaining production service.

CRESCENT BELT FASTENER CO., 247 Park Ave., New York City, is distributing a service data chart in card form, 3½ by 9 inches in size, which describes specifically the means and methods of insuring best results in joining belts from ¾ inch to 18 inches and over in width. The specifications have reference to leather belting and fabric belting. Prices of Crescent plates and rivets are given on the back of the card. Copies will be sent upon request to those interested.

STERLING GRINDING WHEEL CO., DIVISION OF THE CLEVELAND STONE CO., Tiffin, Ohio. Pamphlet entitled "The Art and Science of Grinding," containing a description of Sterling wheels and giving prices of the different types, as well as tables for selecting wheels for different classes of work and various operations. Considerable general information of value to the user of grinding wheels is included, such as correct operating speeds, rules for obtaining surface speeds, tables of wheel circumferences, shapes of wheel faces, etc.

WODACK ELECTRIC TOOL CORPORATION, 23 S. Jefferson St., Chicago, Ill. Catalogue entitled, "Electric Tool Facts," containing description and tables of dimensions, capacity, prices, etc., covering Wodack portable electric drills, grinders and buffers equipped with the automatic stop switch control. Illustrations show these tools in use for drilling, reaming, wood-boring, grinding, cleaning, polishing, buffing, screw-driving, routing, glass drilling, marble drilling, sawing, cylinder lapping and other industrial purposes.

BOSTON GEAR WORKS, Norfolk Downs (Quincy), Mass. Catalogue 44, containing a complete list of Boston gears, including dimensions, prices and other essential data. The design of these gears is standardized, and 600,000 are kept in stock for immediate delivery, among which there are 2300 sizes to select from. However, special gears can be made to order when necessary. The booklet contains directions for ordering and general information on gearing, such as the application of gears in parallel drives, tables of strength of gear teeth, diametral pitch, circular pitch, etc.

GARDNER MACHINE CO., 414 E. Gardner St., Beloit, Wis., has just brought out the first number of a bi-monthly publication, known as the "Gardner Grinder," the purpose of which is to supply manufacturing executives with data relating to the production of flat surfaces by grinding and polishing. The aim is to publish articles describing what is being accomplished on Gardner disk grinders and to give helpful information on the proper care and operation of these machines. The first issue describes the use of Gardner grinders in the plant of Fairbanks, Morse & Co., manufacturers of gas engines, pumps, marine engines, etc. Copies of the publication will be mailed regularly to superintendents, purchasing agents, grinding-room foremen, master mechanics, production engineers, and others who may be interested in grinding.